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CONTENTS

Experts Comment on Long-Term, Mid-Term S&T Development Program

40080161a Beijing ZHONGGUO KEJI LUNTAN [FORUM OF SCIENCE AND TECHNOLOGY IN CHINA] in Chinese No 1, 1989 pp 23-25

[Article: "Some Experts' Opinions on the 'Mid- and Long-Term Science and Technology Development Program'"]

[Text] At a recent symposium at the State Science and Technology Commission research center, experts from scientific and technical departments and advanced academies and schools in the capital discussed aspects of the drafting of a mid- and long-term science and technology development program for China. The views that were expressed are summarized below.

1. Overall Conception

a. Nature of the Program. Most comrades believe that the general ideas of the current draft program, which concentrates on topics related to China's scientific and technological development strategy, principles and policy, has a strong ideological, guidance and policy character and that it is a program document. This is good. The program's emphasis on linking science and technology to the economy and on solving problems of industrial and agricultural production and social development is correct. But more emphasis should be given to the subject matter of science and technology themselves. A few comrades believe that the program should focus on the development of science and technology proper and should not devote much space to specific economic questions. b. The Programmatic Character of the Document. Some experts believe that the program should be specifically focused and should emphasize the solution of actual problems. They suggest that clear-cut answers should be given to the currently most disputed questions. These include the fact that science and technology have not yet truly been taken seriously by society as a whole, that basic research is being neglected, that investments in science and technology are low, that research personnel receive low pay, that there is considerable turnover in their ranks, and that scientific research is run as a short-term activity. The program should resolve certain problems in specific areas. c. The focus of the program should be on the near and middle term. The situation is changing so fast that assumptions extending

over too long a time period are not realistic. d. Historical experience should be conscientiously summarized. The "two bombs and one satellite" programs policy was the result of a breakthrough effort with highly centralized leadership and of implementing directive plans. This tradition must not be cast aside. Such areas as optical fibers, superconductivity and large-scale intergrated circuits require concentration of forces for an all-out effort. e. Some experts believe that in major scientific and technological breakthrough efforts that affect the national economy and the people's livelihood, scientific and technical activities must be primarily regulated by plan.

2. Principles and Objectives of the Development of Science and Technology

a. Some experts believe that the general policy that scientific and technological activity must be oriented to economic construction and that economic construction must rely on science and technology is good, but that it still has not reflected the path-breaking and guiding role of science and technology. Principles should be developed. Different development principles and policies should be stated with reference to the different characteristics of basic research, applied research and development research: they must not all be treated in the same way. b. Some experts believe that China's current scientific and technical development should basically involve following the leaders. Our strategy should be a following and assimilation strategy. Innovation should be encouraged, but the costs and risks are too great. In general, they should not be excessively great. The assimilation policy, too, must not be entirely all-embracing; it must concentrate on the technological modernization of traditional industries. This is the main battlefield. c. Some experts believe that the results of scientific and technological development should be diversified, and that the same standards should not be applied throughout the country. There is currently an extensive technological hierarchy, ranging from world-class to extremely backward technologies. There is a great gap between the coastal region and the interior. There should also be a preferential policy in developing science and technology: capabilities should be concentrated on effective work in the coastal region, with its population of 100 million, making it into a highly developed region, before disseminating science and technology to the interior. The extreme imbalance of scientific and technological development should be the basic starting point for drafting the mid-term and long-term scientific and technological development program. d. Some comrades believe that the hierarchy of current objectives in the program is not clear and that there is a lack of planned system of scientific and technological objectives and of three-dimensionality. An effort should be made to have a mutually complementary set of economic and social objectives and scientific and technological objectives. The objectives must be multilayered. The attainment of a society that is fed and clothed and that has the basic comforts implies economic objectives and scientific and technological objectives. There must also be objectives in regard to eliminating the things

that are most backward. The objectives must be of the breakthrough type. e. Some comrades believe that the program's objectives are set too high and that future expectations too great and cannot be implemented. In general, from the year 2000 to 2020, China's science and technology will find it difficult to join the ranks of the leaders across the board. Making vigorous efforts in individual advanced technologies is easy, but their comprehensive popularization and dissemination is difficult. If we consider the technological level of China and the developed countries, the difference is no more than 10 or 20 years, but in terms of dissemination and applications the gap may be as great as several decades or more than 100 years. It would be good to make an effort in high-energy acelerator technology, but China lacks the money to do so.

3. Basic Research

a. One view is that the long neglect of basic theoretical research in China is the basic cause of the inadequate technology development today. The Gang of Four labeled basic theoretical research as "divorced from reality" and entirely eliminated it. The situation changed for the better after the [1978] nationwide scientific conference. We must not label scientific and technical personnel as being divorced from reality. In the 1960's, scientific and technical personnel made an immense contribution to the development of national defense; although they did not directly serve the national economy, this was not a situation of theory being divorced from reality. The country wanted them to serve national defense, and it was an area in which scientific and technical personnel should have been involved. The program states that we must "continue to attach importance" to basic research; this entails an increase in investments. By the year 2000, allocations for basic theoretical research should account for 15 percent of total research funding. Funding for applied research should be even greater. b. Another viewpoint is that with China's economic limitations, basic research, especially pure basic research that is remote from the needs of economic development, cannot be pursued on a large scale. In general, China cannot undertake large scientific projects such as high-energy accelerators, magnetohydrodynamic power generation and the like. This is simply China's situation. The state should set rational proportionalities between basic, applied and development research.

4. Developing High-Technology Industries

a. Some experts believe that China has certain definite advantages in developing high-technology industries and that we should be somewhat more optimistic. Actually, high-technology industry includes both high technology and large-scale conventional technology. If we solve the key problems of high technology, production costs will decline and China will become competitive and will be able to develop rapidly. We must not divorce high technology from traditional industries and develop it in isolation. High technology invigorates traditional industries rather than replacing them. b. Development of high-technology industries requires that the state provide funding and planning and create the climate. It should not be pursued in bits and pieces. Exclusive adherence to the "single road between the center and the countryside" model is inadequate: it involves primarily commerce and cannot make a real, major contribution to developing China's high-technology industry.

5. Personnel

a. Many experts believe that the 10 years of chaos lost us a generation. In the last 2 years, youth have again been subjected to the attack that "scholarship is useless"; scientific and technical personnel have rather low morale and there is a good deal of turnover. Our task is to train a high-quality scientific and technical force oriented to the 21st century. But if we continue as we are at present, the quality of the personnel will tend to decline and there will be a lack of successors, which will harm the overall improvement of the people's scientific and cultural level. b. The main cause of the above situation is that scientific and technical personnel's wages are too low, and that the wages for physical and mental labor have long been upside down, so the scientific and technical personnel have difficulty making a living. The policy of letting some people get rich first is correct, but the question is: Which group? The current situation is that highly qualified specialists are poor, while speculators are getting rich; this is not normal. c. The program must correctly provide for a great improvement in the wages and benefits of scientific and technical personnel. A major policy with major measures is needed. Where is the money to come from? Some experts believe that if we resolutely cut back certain projects there will be money enough. d. To create the necessary manpower, particularly great emphasis should be placed on occupational training and on developing a highly qualified technical and engineering contingent.

6. Increasing the Strength of Investment in Science and Technology

a. Some of the experts believe that the percentage of China's science and technology investment is too low: the actual funding for pure research and development is actually about 0.5 percent of the GNP. This is lower than in the developed countries and even than in many developing countries. Our predicted rates of investment are also lower than immediately after liberation and in the 1950's and 1960's. b. Some experts believe that scientific research funding should be primarily allocated by the state. China's enterprises are very weak in terms of funds, and if they have any money they spend it on bonuses. The program states that 50 percent of the funding of scientific research should be contributed by enterprises, but this appears difficult to achieve for a long time to come. Everywhere in the world, the more backward a country is, the greater the extent to which it must rely on government funding to develop science and technology. c. To increase investment strength, we must also emphasize efficient use of funds. While assuring that the priority areas are provided for, we should conscientiously trim down projects and personnel and concentrate on "limited objectives and key breakthroughs." At present, research projects are dispersed, facilities are dispersed, and personnel, funding and resources are dispersed. The benefits of science and technology cannot be constructed on a diffuse foundation.

7. The Science and Technology Leadership System

Developing science and technology requires a headquarters that takes centralized responsibility and is highly efficient. The headquarters before the Cultural Revolution had authority: everyone carried out its decisions and on one quibbled about its prohibitions. Things have now changed greatly, and there are actually multiple centers of authority and multiple leadership, with much duplication, waste and wrangling, and major undertakings cannot be carried out. The program should solve this kind of overall problem.

8. The Science and Technology System

What should the model be for China's future science and technology system? What should the orientations of research organizations under the various ownership systems be, and to whom should organizations for basic, applied and development research be responsible? What should we encourage, what should we regulate, and what should we oppose? All of these matters should be subject to macroscopic decision-making and guidance and all should be embodied in the program. b. Whether or not system reform is successful depends on whether it has made the enterprises take more initiative in utilizing new technologies and whether a mechanism for technological progress has been created. The current situation is still not very encouraging. c. Some experts say that the reform of science and technology has already had great and undeniable achievements, but that some research institutes entirely emphasize "creating earnings" and use their profits for bonuses: is this orientation correct or not? When we let research organizations enter the enterprises, will China's multitude of medium and small-sized enterprises be able to nourish research? It is not realistic. The orientation of research institutes is integration into society. Some experts stated that it is worth studying whether it is suitable for the Chinese Academy of Sciences to have "one academy and two systems." d. Some experts stated that it is entirely correct and necessary for science and technology to serve the economy and that this approach should be strictly adhered to for a long period. No one opposes having science and technology serve the economy, but science and technology have their own laws. The market cannot decide everything, and science cannot make earning money its objective. We must not rely on the market mechanism in developing science and technology. Even in the capitalist countries, scientific research is not entirely concerned with earning money. e. A system for dissemination of agricultural science and technology should be worked out in the program.

9. Structure and Organization of the Program

a. The majority of comrades believe the structure as currently mapped out is good. The introduction should cover all of the general matters and clearly state the principles and policy of each section. The body of the text should not repeat what has already been said in the introduction, but should discuss the specific tasks of each field. b. The introduction should start with a

brief description of world scientific and technological development, the current strategic role and function of science and technology, and the rigorous international environment that China faces. It should discuss China's circumstances and current tasks. Next, it should deal with strategic changes: i.e., the changeover from a main focus on having science serve defense to having it serve economic development. Finally, it should state future objectives, priority fields and major policy measures. c. Some of the specialists believe that the organization of the program should be revised. The alliance of natural science and social science should make up separate section. Soft science should be dealt with in this section. Urban development should also have its own section, because urban problems are piling up. Ecology and the environment should make another section. Pollution of the atmosphere and rivers, cutting of forests, and desertification are now very severe. China has truly reached the crossroads. There is serious waste of natural resources, particularly nonrenewable resources, which is cause for distress. We should emphasize their integrated development, integrated utilization, and integrated management. "Greening" should be made national policy. Some experts also believe that dealing with agriculture without dealing with rural development is not acceptable and that a new section on the latter subject should be added.

10. Other Matters

a. Regarding the slogan of "self-reliance." One viewpoint is that self-reliance is an excellent tradition in China that is capable of encouraging the people and of producing good results and that it should be emphasized in the program. Another view is that the trend of world scientific and technological development is further internationalization. The past emphasis on self-reliance did indeed have its positive side, but it promoted a self-contained mentality and produced many abuses, it should no longer be advocated in science and technology. b. Some experts suggest that the relationships affecting China's scientific and technical development should be expressed in terms of the following phrases: "emphasis on basic, applied and development research, with primacy to development research"; "emphasis on both long-term and mid-term tasks, with primacy to the mid term"; "emphasis on both independent development and assimilation of foreign technology, with near-term primacy to the latter"; "emphasis on both following along and catching up, with near-term primacy for the former"; and "emphasis on both the coast and the interior, with near-term emphasis on the coast." c. The objective of drafting the program is to get the objectives conscientiously carried out, and this requires the relevant policy guarantees and a green light in terms of funding and conditions.

1978 Deng Speech on Scientific, Technical Personnel Said Still Relevant

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[Article by Hu Ping [5170 1627]: "A Major Breakthrough in Scientific and Technological Development in China"]

[Text] 1. During the 10 years of chaos, the Lin Biao counterrevolutionary clique and that of the Gang of Four brought science and technology in China to an unprecedented calamity. Large numbers of scientific research organizations were wrecked, and scientific and technical personnel suffered all manner of persecution and humiliation. But the greatest damage was that in judging science and technology and scientific and technical personnel on theoretical grounds, they unjustly found them guilty on two counts. The first was that modern science and technology are a product of capitalist consciousness and a hotbed of crime that tends to restore capitalism. The other was that scientific and technical personnel are capitalist intellectuals and are the social basis for the restoration of capitalism. These two charges were publicized with great fanfare and disseminated widely, to the extent that they became universally familiar. With these two labels, China's science and technology sank from sight.

The national science and technology conference held in 1978 was a major, epoch-making event in China's scientific and cultural field following the smashing of the Gang of Four and a major turning point in the development of China's science and technology. In particular, Comrade Deng Xiaoping's speech at the conference was a political, ideological and theoretical unmasking of numerous fallacies of the ultra-"left" tide that had been predominant for many years. It set right many historical disputes that had been subverted by Lin Biao and the Gang of Four and reestablished science and technology in China on a reliable foundation.

Comrade Deng Xiaoping's speech was rich and profound and put forth numerous incisive views. The most important thing was its emphasis on expounding the Marxist principles that science and technology are productive forces and that scientific and technical personnel are a part of the working class. At that time, when the "left"-leaning tendency and its political power were still in command, it was extremely acute and bold, urgent and necessary to state such

propositions. A serious trial of strength between Marxism and anti-Marxist ultra-"left" ideology developed around Comrade Deng Xiaoping's speech. The outcome was of course that the Marxist force in the party, represented by Comrade Deng Xiaoping, overcame the anti-Marxist force. Comrade Deng Xiaoping's views received the enthusiastic support of the entire party, of all the people, and of all scientific and technical personnel and produced a powerful and far-reaching influence on subsequent work.

2. The idea that science and technology are productive forces is essentially a basic principle of historical materialism. From the viewpoint of historical materialism, productive forces are formed of the materials of production and manpower. The use of the materials of production has always been related to the specific scientific and technical level, and manpower is personnel with specific scientific and technical knowledge. People's use of the implements of production and their mastery of production capabilities have always been highly uneven and labor productivity has always varied widely; ultimately, this depends on differences in scientific and technical level. Marx said, "Labor productivity is governed by numerous circumstances, including the average proficiency of the workers, the level of scientific development and the extent of its use in processes." He also stated that "Labor productivity develops constantly along with science and technology." (Ma-en quanji [Complete Works of Marx and Engels], Vol 23, pp 53, 664). Hence, science and technology are components of productive forces rather than belonging to the superstructure, to say nothing of being a product of "capitalist consciousness." When we constantly state that science and technology are part of spiritual civilization, we refer to the fact that they have created lofty spiritual values such as the search for truth, the spirit of innovation, and the like; we do not refer to class consciousness. Science and technology are productive forces: they have no class character and can be used by either the bourgeoisie or the proletariat. When we speak of modernization, we refer to the use of modern science and technology to transform the entire national economy and to establish it on the basis of large-scale production that makes use of modern science and technology. To label scientific and technical personnel as "capitalists" is to deny the key position and role of science and technology in socialist construction.

The correct theoretical determination of the affiliations of science and technology and the clear understanding that science and technology are not states of consciousness, but are productive forces, laid the ideological foundation and created the most favorable conditions for China's scientific and technological development in the modern period and for the union of science and technology with the economy. In 1981, China enunciated the new principle of coordinated development of science and technology, the economy and society and clearly specified that promoting economic development is the primary task of scientific and technological activity. Subsequently, we also stated the strategic principle that science and technology must be oriented to economic development and that economic development must rely on science and technology, which further enriched and improved the general policy for development of science and technology. In 1982, at the 12th party congress,

science and technology were included among the strategic foci of China's economic development. In 1983 the central party authorities and the State Council leadership issued the urgent assignment of meeting the challenge and opportunity of the world revolution in new technology, calling upon leadership personnel at all levels to attach even greater importance to science and technology, and stating that with mankind facing new turning points and tests, we must rouse ourselves and strive to catch up with this great world revolutionary tide, rather than being left behind and missing out. To further liberate scientific and technological productive forces, in 1985 the central authorities made the decision to carry out a reform of the science and technology system in which they enunciated the viewpoint of converting scientific and technological results to commodities. Since 1986, we have also announced the "two policies" (loosening restraints on scientific research organizations and on scientific and technical personnel) and the policy that science and technology should enter the economy and grow into the economy. At the 13th party congress, developing science and technology was raised to a leading position in China's economic development strategy, and the idea that science and technology will make China prosper and the historical task of conscientiously converting economic construction to a reliance on scientific and technological progress were enunciated.

China's scientific-technical and economic development over the past 10-odd years makes evident the correctness and importance of the theoretical thesis that science and technology are productive forces and the great influence that it has had on China's modernization. In a certain sense, the specification of China's principles and policy of scientific and technical development over the last 10-odd years and the establishment of a series of new concepts were inseparable from this revolution. And it was under the leadership of these ideas that the linking of China's science and technology with its economy was able to achieve such great results.

At present, the important position and role of science and technology have been unprecedentedly heightened. At a recent reception for foreign visitors, Comrade Deng Xiaoping stated that science and technology are not simply ordinary productive forces, but are "primary" productive forces. In other words, they are the primary, most active and decisive factors among the productive forces. Increasing social labor productivity, strengthening the country's power, improving the people's quality of life and satisfying the continuously growing material and cultural needs of the entire society all depend on scientific and technical progress. The world revolution in new technology that is now proceeding by leaps and bounds has made science and technology penetrate all aspects of human society to an unprecedented extent. The fierce economic competition is increasingly developing into a competition in science and technology. In this competition, if economically backward countries attach due importance to science and technology and grasp their opportunities, they will be able to advance rapidly; and countries that ignore science and technology will inevitably fall behind economically and will gradually decline. Currently, China is in the initial stage of socialist

society, and we shoulder the double task of promoting the revolution in traditional production and catching up with the world revolution in new technology. The key to carrying out these two tasks consists of unwaveringly relying on scientific and technological progress. In these terms, we can understand the profound principle of raising the development of science and technology to a primary position in the strategy for national economic development and the profound implications of treating science and technology as "primary" productive forces.

3. Once we recognize that science and technology are productive forces, we must necessarily answer the question whether persons engaged in science and technology are mental laborers or exploiters; and in particular, under China's current circumstances, whether scientific and technical personnel are part of the working class or part of the bourgeoisie. This dispute has long been subverted. Starting in the early 1950's, and particularly with the 1959 anti-rightist struggle, China's intellectuals were labeled as capitalist intellectuals. In the Cultural Revolution this viewpoint was carried to its extreme. The intellectuals became "loathsome good-for-nothings" and famous scholars became "reactionaries in power."

What are the basic views of Marxism on this subject? The intellectuals themselves are not a separate class. In capitalist society, other than a very small number of capitalist elements who attach themselves to capitalist or who themselves have capital and practice exploitation, and some free professionals who do not exploit others and are not exploited by others, the majority of intellectuals are mental workers who are hired by the capitalists and exploited by them. Marx and Engels always called them "production workers," "production laborers," or "proletarians engaging in mental labor," who created surplus value (Op. cit., Vol 26, Part 1, pp 443 and 432). Marx and Engels never classified these people as capitalists on the ground that they could be influenced by capitalist thought, because from the viewpoint of historical materialism, the basic criterion by which the classes are distinguished is simply people's economic position. To classify the intellectuals under the socialist system as capitalists is even more absurd. Under the present circumstances, more than 90 percent of our intellectuals have been nurtured by the party itself since liberation, and two-thirds have come from working-class origins. Even the intellectuals from non-working-class origins have been educated for many years by the party and ardently love the party and socialism; their wages are their only source of livelihood, and they of course belong to the category of proletarians performing intellectual labor, a part of the working class. The only respect in which they differ from physical laborers is in the social division of labor: how could we regard them as a alien group because they have knowledge, treating them as part of the bourgeoisie?

We can go a step farther and conclude that scientific personnel not only are a part of the working class, but are the most knowledgeable, most exemplary, most advanced part of the working class. From the standpoint of historical materialism, the reason that the working class is historically the most advanced class with the greatest prospects and the reason that it can take a

leadership role in the revolution is none other than the fact that it represents newly arising productive forces and promotes the continuous advance of productive forces. Since science and technology are the most vigorous, decisive factor in productive forces, the mental workers who unite directly with science and technology and utilize the directly [as printed] in production and management naturally are the most progressive and most exemplary elements of the working class. In this sense, scientific and technical personnel are the vanguard of the working class who lead the way in attaining knowledge and that best embody scientific and technological productive forces; this view does not in any respect intentionally "elevate" the image and historical position of scientific and technical personnel, but instead is a restoration of the original historical situation.

Correct resolution of the problem of the class affiliation of scientific and technical personnel and of the entire intellectual sphere laid the theoretical foundations and created the most favorable conditions for large-scale utilization of scientific and technical personnel and intellectuals in the new period to intellectualize and revolutionize the cadres, for thorough use their splendid contributions. Since the 3d plenum of the 13th party congress, many important party and state documents have emphasized the importance of implementing the policy on the intellectuals and have emphasized respect for knowledge, respect for talent, and thorough utilization of the intellectuals' special strengths, enabling them to devote themselves entirely to scientific research, engineering and technology, teaching, creative activity, management, administration and other specialized activities. The documents request that in making major policy decisions in all areas, the party and government conscientiously listen to the views of the relevant experts and invite experts to take part in research, evaluation and the writing of drafts. They emphasize bold selection of leadership personnel from the ranks of the intellectuals and in particular the selection of the best young and middle-aged experts to serve in leadership groups at all levels. In addition, many measures have been taken to improve the working and living conditions of scientific and technical personnel. Chinese scientific and technical personnel of the older and younger generations and the entire intellectual sphere can contribute their wisdom and strength to the socialist fatherland as full partners and with self-respect, and will never again be subjected to various types of political discrimination, censure, exclusion and attack.

4. As modernization becomes more thorough, the position and role of science and technology and of scientific and technical personnel become increasingly important. As we review Comrade Deng Xiaoping's important speech of 10 years ago, we become increasingly aware of its wisdom and penetration. We further realize the strategic position and role of science and technology, and understand that giving further scope to the initiative and creativity of scientific and technical personnel remains an important task for the entire party and the entire country. In the last 10 years, although the party and government have made major efforts in this connection and have achieved major results, the constraints of 3,000 years of the concepts of the small-farming economy, the influence of more than 30 years of the "better left than right" ideological trend, and the errors of neglecting science and technology, despising knowledge, and discrimination against the intellectuals, both in the party and in society, still have not been eliminated. In addition, China

still suffers from many material difficulties, and as a result, we are still behindhand in improving the wages, benefits and material circumstances of scientific and technical personnel. In our real work, blind management that does not respect expert opinion and fails to act in terms of objective laws is still common. Respecting knowledge and talent has still not become the prevailing style. These facts all indicate that learning from, implementing and executing the spirit of Comrade Deng Xiaoping's directive remains a long-term process and that it is still necessary for the party and government, and in particular the cognizant scientific and technological departments at all levels, to accord it due importance and gradually solve the problem.

Technology in the Special Economic Areas in Changchun

40081031a Jilin JILIN DAXUE SHEHUI KEXUE XUEBAO [JILIN UNIVERSITY JOURNAL-SOCIAL SCIENCES EDITION] in Chinese No 2, Mar 89 pp 30-38

[Article by the Nanhu-Nanling Area Strategic Planning Topical Group: "Research on Strategic Planning for the Nanhu-Nanling [South Lake and South Ridge] High Technology Development Region in Changchun"]

[Excerpts] Editor's note: This article was written on the basis of the "Changchun Nanhu-Nanling High Technology Development Region Strategic Planning Research Report." This research project was assigned by the Jilin Provincial Science and Technology Commission. The Changchun City Science and Technology Commission did the actual organizing. It was a soft science project participated in by the Changchun Branch of the Chinese Academy of Sciences, Jilin University, Northeast China Normal University, Jilin Province Economic and Technical Development Research Center, Ministry of Water Resources and Electric Power Songliao Commission Water Resources Protection Bureau, Changchun College of Optics and Fine Mechanics, and other units. It passed expert appraisal and examination directed by the Jilin Provincial Science and Technology Commission on 20 April 1988. The Jilin Provincial People's Government decided to establish the "Changchun Nanhu-Nanling New Technology Development Park" on 13 May 1988 on the basis of this research project.

I. Current Situation in the Nanhu-Nanling Area

A. The advantages of developing high technologies

1. Intellectual resources

The essential condition for developing high technologies is concentrated intellect or concentrated knowledge. Changchun City is the home of the Jilin Province CPC Committee as well as the political, economic, and cultural center of Jilin Province. The Nanhu-Nanling region in south Changchun City is a scientific research and cultural area with concentrated intellect. Changchun City has 770 S&T personnel per 10,000 population, first place among China's large and medium-sized cities. The city has 28 full-time institutions of higher education, 18 of them in the Nanhu-Nanling

area. These 18 universities have 310 professors, 1,255 associate professors, 4,037 instructors (these are 1987 personnel statistics), and over 3,000 enrolled graduate students.

The Nanhu-Nanling area has 39 scientific research organs and a total of 9,476 scientific research personnel, one-half of whom are advanced and mid-level S&T personnel.

The Nanhu-Nanling area also has 12 design academies. They have more than 4,000 S&T personnel, two-fifths of them with advanced and mid-level job titles.

Starting in the late 1950's and early 1960's, the state built several plants in the Nanhu-Nanling area which were dominated by production of electrical products, optical precision instruments, semiconductors, and so on. They have a rather large proportion of S&T personnel who basically possess the conditions to absorb new technologies.

The Nanhu-Nanling area has 883 S&T personnel per 10,000 population, of which 58 are advanced S&T personnel. The ratio between advanced, mid-level, and elementary S&T personnel is 1:4.8:4.9. The advanced S&T personnel include 91 teachers with doctorates and 1,500 with master's degrees. This shows the rather high average scholarly levels of the Nanhu-Nanling area's S&T personnel.

2. Technical equipment

Data from the 1985 National Science and Technology Survey indicate that most of the precision scientific instruments in Changchun City are concentrated in the Nanhu-Nanling area. It has all 23 of the required large-scale precision instruments under unified administration by the State Science and Technology Commission, including large electron microscopes, electronic probes, ion injectors, mass spectrometers, integrated color mass spectrometers, quaternary diffractometers, laser Raman spectrometer photometers, nuclear magnetic resonance wave spectrometers, ion color spectrometers, and so on. Testing and computing personnel have been trained for quite some time and are technically skilled.

Among the primary institutions of higher education and research institutes in the Nanhu-Nanling area, national level and Chinese Academy of Sciences open laboratories which have been built or are to be built include laboratories for enzyme engineering, applied optics, rare earth chemistry and physics, energy spectra, modern electrical analytical chemistry, integrated opto-electronics, artificial intelligence, polymer agglutinated state physics, and others. The state has invested enormous funds in these laboratories and their equipment is precise and of excellent quality. It is a material guarantee and experimental base area for developing high technology and new products.

The Nanhu-Nanling area's libraries hold collections of 12 million volumes, and institutions of higher education have basically formed a network for collecting and circulating scientific and technical information. Many units now use computers for information searching, which has made it convenient for S&T personnel to consult information abstracts.

3. Scientific and technical capabilities

The vast number of S&T personnel in the Nanhu-Nanling area have contributed to the state since the nation was founded. They have made outstanding achievements in research on the "two bombs and one satellite" [atomic and hydrogen bombs, artificial satellite] and the realm of the basic sciences. Incomplete statistics on S&T achievements of the Nanhu-Nanling area from 1980 to 1984 show they made 1,020 scientific research achievements. This is particularly true of State Natural Sciences Awards and State Invention Awards. Changchun City is one of the cities which has received the most high-level awards.

B. Advantageous realms for high technology in the Nanhu-Nanling area

1. The realm of electronic computers

The Nanhu-Nanling area currently has four institutions of higher education, three research institutes, six enterprises under ownership by the whole people, and eight collective enterprises involved in scientific research and production of electronic computers. Jilin University began developing artificial intelligence rather early and has attained advanced levels within China in the areas of theorem verification and expert systems research. They have made achievements in developing expert systems for petroleum, geology, meteorology, medicine, and other fields. They have begun developing the fifth generation of computers, photon computers, and optical disk memories. Changchun's advantages in electronic computers lie in the area of software.

2. The realm of electronics, optics, and opto-electronics

Jilin University's research levels are first in China in the areas of silicon and gallium-arsenic epitaxy technologies, binary system, ternary system, and quaternary system semiconductor materials, opto-electronic materials and components, and semiconductor lasers.

Optics is one of Changchun's biggest advantages and they have made major contributions in scientific research. They hold substantial advantages in optical design, optical glass and crystals, optics technologies, opto-electronic code disks, optical grating technologies, and optical instrument development. The Changchun Institute of Optics and Fine Mechanics is China's sole institution of higher education which provides specialized integrated training for optics, fine mechanics, and electronics personnel. The Nanhu-Nanling area has four rather large optics plants which are the foundation for the development of the optics industry.

3. The realm of new materials

The Nanhu-Nanling area's advantages in new materials are in the fields of polymer materials, luminous materials, magnetic materials, and opto-electronic materials. Quite a few scientific research personnel in the Nanhu-Nanling area are working on polymer materials, centered mainly in the Changchun Applied Chemistry Institute and Jilin University. Jilin University's artificially synthesized diamond film has a rather high scholarly level and substantial economic benefits. Several achievements have been made in the area of engineering plastics. A large number of talented people in the Nanhu-Nanling area are working on radiation cross linking materials. Three-fourths of all Chinese personnel working in this field are concentrated here and they have made substantial achievements. Heat-shrink materials are now being produced in small amounts and providing considerable benefits. The levels of development of solid luminous materials and of III and V group compound materials are first place in China. Rather high levels have been attained in the areas of volume and functions with barium fluoride and calcium fluoride crystals, and they can be exported in large amounts. Levels in rare earth magnetic materials, plastic magnetic materials, and other opto-electronic materials also fall within the scope of the Nanhu-Nanling area's materials advantages.

4. The realm of bioengineering

Nearly 300 talented people in the Nanhu-Nanling area are involved in biotechnology development and research. Jilin University is now building China's only enzyme engineering laboratory, and major advances have been made in enzyme structure and function, enzyme molecular chemistry modification, and production of enzyme products. Northeast China Normal University has made technical achievements in genetic engineering, polysaccharide biochemistry, microbes and fungi development, and other areas, and some have attained advanced levels within China. The Changchun Biological Product Institute has made major advances in research on various types of vaccines and is one of China's most important vaccine production base areas. The Jilin Provincial Light Industry Design and Research Academy has mastered the glutamic acid, lysine, yellow maize wine, and other fermentation technologies and transferred them to enterprises.

C. The main problems in developing high technology in the Nanhu-Nanling area

1. Lack of matchup between scientific research capabilities and technical capabilities. Although the Nanhu-Nanling area has scientific and technical advantages, actual research indicates that scientific research and educational forces are rather strong while design and technical forces are very weak. Technical forces in most enterprises are extremely thin and their ability to absorb and develop new technologies is poor.

2. Changchun City's economic forces are not strong. Changchun has a population of 1.8 million but only 9 billion yuan in value of industrial output, and the industrial value of output in the Nanhu-Nanling area accounts for just 9 to 10 percent of the city as a whole.

3. Disjointed administrative systems are not conducive to integration of S&T with production. For a long time, S&T and economic decision making and planning have been detached from reality and there is no coordination between the parts of the system. Everyone manages things in their own way and very few truly decide real problems on the basis of objective S&T and economic laws.

4. There is a lack of preferential policies for attracting talented people. Many advanced and mid-level personnel are leaving Changchun City while many elementary personnel are entering the city.

II. Planning Goals for the Nanhu-Nanling Area

A. The strategic significance of building the Nanhu-Nanling area

1. Use the challenges China faces to see the necessity of developing high technology. Developing high technology is not just a tide in the developing nations. It is also a primary way to invigorate the economies of Third World nations. High technology has become one of the motive power which promotes economic and social development in the world. [passage omitted]

2. Use economic development in Changchun to see the necessity of establishing the Nanhu-Nanling area. The State Council pointed out in its reply to the "Comprehensive Urban Plan for Changchun City" that: "Future development in Changchun should make full use of advantages in the areas of scientific research and education. Build Changchun City into an economically prosperous, scientific and educationally developed, environmentally beautiful, and convenient living socialist modern city." The biggest problem in Changchun's economic development at present is still the adoption of quantitative expansion extensive economic models which rely primarily on inputs of capital and labor power for economic growth. Technical progress factors account for only about 30 percent. The gross value of industrial and agricultural output in Changchun City during the Sixth 5-Year Plan grew at a 10.7 percent yearly increase (11 percent for industry). The annual growth rate in the Seventh 5-Year Plan was 9.7 percent yearly increase (9 percent for industry). If we continue to follow this type of economic development pattern in the future, the city's 3,000-plus enterprises will still maintain the original industrial structures and it will be very hard to ensure sustained stable growth of Changchun City's economy after 1990. This requires that Changchun City's economy gradually make a transition from a "quantitative expansion-type economy" to a "technical progress-type economy" and "performance-type economy."

The intellectual advantages of the Nanhu-Nanling area of Changchun City are undoubtedly the predetermining condition for building a high technology development zone. By building this area, we are creating a "micro-climate" which will "release" the "energy" contained in these intellectual resources in an interior city. With preferential policies to initiate and rationally utilize these intellectual resources by converting them to technical and economic advantage, a powerful motive force would be formed to promote economic development. This means the formation of a benevolent cycle of intellect--technology--economy--intellect in the Nanhu-Nanling area. [passage omitted]

C. Strategic planning goals for the Nanhu-Nanling area

1. The deployment model for the Nanhu-Nanling area

Deployments in the Nanhu-Nanling area will adopt an umbrella-shaped radiative source model. 1) First, select a suitable section of road in the Nanhu-Nanling area and build a "Changchun S&T Street" like the electronics street in Zhongguancun, Beijing, and encourage the entire city to engage in high technology development and management activities, while at the same time attracting high technology research and development personnel or units from China and foreign countries to open up enterprises and shops on this street. Make this the first step in creating the Nanhu-Nanling area and gradually invigorate high technology development, production, and management activities. 2) Unused vacant land in tne Nanhu-Nanling area can be demarcated with the government or institutions of higher education, research institutes, and enterprises providing capital to build a high technology enterprise "incubator" to serve as a high technology product development center. 3) To maintain the beautiful environment in tne Nanhu-Nanling area, it would be best not to build more large enterprises which consume large amounts of energy, use a great deal of water, and cause serious pollution. 4) An appropriate area can be selected outside the Nanhu-Nanling area (including the city's suburbs and counties under its jurisdiction) to establish biotechnology enterprises and new materials technology enterprises. In this way, the Nanhu-Nanling area would be a high technology radiation source which would radiate its advanced scientific research achievements and technologies to all of Changchun City and all of Jilin Province, and even to other regions throughout China. This is a rather ideal deployment model for the Nanhu-Nanling area.

The Nanhu-Nanling area's high technology enterprises are open enterprises which are oriented toward the world. Thus, competition in international markets and establishing a window for export-oriented activities should be the primary goals of all development and economic activities in the Nanhu-Nanling area.

2. Planning goals

The strategic planning goals for the Nanhu-Nanling area are: use systems development of the area's scientific research and educational advantages and promote multi-level and multi-pattern integration of scientific research with production, accelerate the pace of conversion of scientific research achievements and assimilation of imported technologies, accelerate technical transformation in traditional industries, focus on development of knowledge-intensive and technology-intensive products, promote coordination of S&T, the economy, and society in the area, and invigorate the economy of Changchun City. After about 15 years, the gross value of industrial output from the Nanhu-Nanling area would reach 4 billion yuan and overall S&T levels would attain advanced nationwide levels and enter the advanced ranks of the world in some S&T realms. Moreover, the region's per capita GNP would attain advanced levels within China for the same period, and there would

be comprehensive improvements in the quality of life, quality of services, and environmental quality in the Nanhu-Nanling area.

The nucleus of the strategic goals for the Nanhu-Nanling area is to promote economic development, expressed mainly as an increase in the gross value of industrial output, and gradually increase the gross value of output in high technology industries to a substantial portion of Changchun City's industry. According to 1985 statistics, the value of output for high technology products in the Nanhu-Nanling area was just 240 million yuan, equal to 43 percent of the gross value of industrial output for the Nanhu-Nanling area and 3.6 percent of the gross value of industrial output for Changchun City. Development forecasts for the Nanhu-Nanling area indicate that with 1985 as the base year, the value of output from high technology in the Nanhu-Nanling area could reach about 500 million yuan within 5 years, while the value of output from the area's traditional industries could reach 530 million yuan (calculated at a 10 percent average annual growth rate), so the gross value of industrial output in the Nanhu-Nanling area would reach 1.03 billion yuan. The next 5 to 10 years are precisely the growth period for most high technology products now being developed in Changchun. The value of output during the growth period of high technology products in foreign countries has in general grown at an annual rate of more than 20 percent or even much higher rates. If we compute on the basis of a 25 percent average annual growth rate, after 15 years from the start of implementation of the Nanhu-Nanling area plan, the value of output in high technology industries in the area could reach about 3 billion yuan and the added value of output in traditional industries would push the gross value of industrial output in the Nanhu-Nanling area past 4 billion yuan.

3. Ideas for phased implementation

To attain the above strategic goals, about 15 years would be required from the start of implementation of the strategic plan for the Nanhu-Nanling area to basically achieve a scale in the area. These 15 years can be divided into three stages:

a. Initial period - the capital accumulation period. This stage will mainly involve development of small-scale or administrative-type high technology products. On the basis of a focus on development of 20 high technology starting projects, three to five high technology industry growth points with a value of output in excess of 10 million yuan will be supported and the traditional industries of the Nanhu-Nanling area will be transformed. New administrative management systems with full development vigor would be established and scientific research, development, production, and management colony advantages would be formed.

b. Middle period - the high technology industry development period. During this stage, on the basis of the State 863 Plan and the preliminary formation of high technology industries, certain focal projects will be chosen for investment and development to build one or two high technology industry base areas influential within China, and renovation of management systems will be completed.

c. Later period - the high technology development zone formation period. This stage will bring rapid and stable development of high technology industries to the Nanhu-Nanling area and make it one of China's high technology radiation centers. It will establish enterprise group colonies with stronger economic capabilities and attain a preliminary scale in the high technology development zone.

Implementation of each stage will require about 5 years.

III. The Focus of Plans for the Nanhu-Nanling Area

The principles for determining the focus of plans are: S&T development trends, S&T advantages in the Nanhu-Nanling area, the needs of economic development in Changchun City and Jilin Province, and projected results in high technology markets. Preliminary debate has led to the following high technology planning projects (medium and long-term projects) and starting projects for the Nanhu-Nanling area:

A. High technology plan projects

1. In the area of microelectronics and computer technologies: 1) Electronic computer software; 2) Artificial intelligence computers; 3) Network and distributed-type computer systems; 4) Optical disk memories; 5) Computer-aided design (CAD) and computer-aided manufacturing (CAM).

2. In the areas of optics, opto-electronics, and automation technologies: 1) Basic optics technologies, optical lenses, mid-grade and top-grade cameras, optical instruments, and optical engineering; 2(Lasers and application technologies, laser measurement and processing equipment, laser screening and treatment facility, laser spectrograph; 3) Opto-electronic technologies, light-emitting diodes, new types of optical sensors, new types of photoluminescent and electroluminescent devices and display equipment, optically integrated and concentrated opto-electronic components, and optical fiber communications materials; 4) Opto-electronic code disks and numerical display and numerical control technologies, circular diagraphs and displacement measurement grating graphs, and numerical display and numerical control processing equipment; 5) Information transmission technologies, new types of movie and television devices, materials, and equipment, and electromagnetic screening and superconducting materials.

3. In the areas of new materials technologies: 1) Aluminum alloys, rare earth and aluminum alloys, and other special alloys; 2) New types of special cast iron and metallic compound materials; 3) Optical glass, plastic optical materials, and artificial crystals; 4) Semiconductor opto-electronic materials; 5) Engineering plastics; 6) Irradiated polymer materials; 7) Film polymer materials; 8) Polymer assistants and oilfield polymer materials; 9) Polymer adhesives.

4. In the realm of bioengineering: 1) New enzyme products; 2) Unicellular proteins; 3) New bacteria strain; 4) Improved crop and animal varieties; 5) Biological pharmaceuticals; 6) Food additives; 7) Vaccines.

B. High technology starting projects

1. In the realm of microelectronics and computers (three projects): 1) Electronic computer software; 2) The Cambridge ring local area network; 3) Intelligent products for use in vehicles.

2. In the realm of optics, opto-electronics, and automation (seven projects): 4) Machine tool industry numerical displays and numerical control equipment; 5) Electronic printing equipment; 6) Static electricity dust removing product series; 7) Optical lenses and top and medium-grade cameras; 8) Eyeglass industry; 9) Intelligent household electrical appliance products; 10) Lasers and laser medical equipment.

3. In the realm of new materials (eight projects): 11) Aluminum alloys; 12) Engineering plastics and polyetherketone; 13) Radiation thermal cross linking materials; 14) Polymer film materials; 15) Color washing and printing mixtures; 16) Plastic optical materials; 17) Artificial crystalline barium chloride and calcium chloride; 18) Fluorescent powder.

4. In the realm of bioengineering (two projects): 19) For zymin, Changchun City should build an enzyme pharmaceutical plant with a yearly production capacity of 1,000 tons; 20) Urokinase.

C. High technology industry groups (six)

1. Computer group.

2. Photographic materials group.

3. Numerical display and numerical control group.

4. Engineering plastics group.

5. Luminescent materials group.

6. New enzyme products group. [passage omitted]

IV. Operational Mechanism of Nanhu-Nanling Area

1. Make intellectual development the vanguard. Management measures in the Nanhu-Nanling area should benefit intellectual development. Intellectual development refers to the liberation of man's intellect from his brain and integration with practice to create wealth for society. The primary task for the Nanhu-Nanling area is to create conditions which attract and concentrate S&T personnel. Thus, preferential policies in the Nanhu-Nanling area are first of all policies which give preference to S&T personnel.

2. Support pioneers in establishing enterprises. The high technology development region should actively support pioneers in establishing enterprises and encourage inventors to convert their invention achievements themselves into material products. The Nanhu-Nanling area should "foster" and give policy preferences to high technology enterprises created by S&T personnel. Pioneer centers can be established for special training of pioneers and to provide experimental, capital, technical consulting and other conditions to pioneers.

3. Encourage "fission" in old enterprises. Having old enterprises which produce traditional products undergo "fission" to create new enterprises which produce high technology products is one important way to form high technology enterprises. The advantages of this method are that the pioneers in the old enterprises have already been tempered in all areas and have definite technologies and experience, so the success rate is high and the risk small.

4. Encourage cooperation by universities, research institutes, and enterprises. Close integration of institutions of higher education, scientific research organs, and industrial enterprises is an important aspect of operational mechanisms for management systems in high technology development zones and the governments of many developed nations have tried all possible methods to promote this type of cooperation. High technology development zones should encourage universities and research institutes to establish high technology enterprises, either by themselves or in conjunction with enterprises. University faculty members and scientific research personnel can take on joint appointments at enterprises and S&T personnel in enterprises can receive training at universities or do development and research.

V. Policies, Laws, and Regulations

There are two main experiences in foreign countries in developing high technology: one is establishing laws, the other is formulating preferential policies.

In setting up the Nanhu-Nanling area, the first thing is to establish provincial laws to confirm its essence and status as an S&T special economic zone and then to implement special preferential policies like investment policies, technology policies, high technology enterprise operation policies, personnel policies, taxation policies, educational policies, information policies, and so on.

The nucleus of policies implemented during the creation stage of the Nanhu-Nanling area is to attract investment and personnel. Thus, we first of all should implement the following policies:

A. Investment policies

For 5 years after establishment of the Nanhu-Nanling area, the provincial and city governments should set aside a specific amount of capital each year to build and improve communications, transportation, residential,

and various public service facilities to create an excellent investment environment for Chinese and foreign investors and to improve the living conditions of pioneers.

Establish a risk investment bank or risk fund commission, and encourage Chinese and foreign business units, plants and business, and individuals to participate in risk investments. The risk capital raised can be used in the form of loans to support the units and individuals who are pioneering high technology industries. Social capital raising also can be done via bonds and debentures, shares, and various other arrangements including making use of the latent roles of various factors of production already imported. Simplify examination and approval procedures for investments by foreign businessmen.

B. Technology transfer policies

The Nanhu-Nanling area will permit units or individuals to come to the area to transfer advanced technologies or establish enterprises. Their technology transfer fees can be taken out of product profits and paid in full in the form of cash in scheduled payments to units or individuals, or they can become shareholders for the cost of the technology and implement profit dividends. The technology transfer fees, shares, and dividends earned by individuals can be exempted from income taxes.

The Nanhu-Nanling area should provide affluent living conditions to all Chinese and foreign experts who come to the area to transfer their advanced technologies. The Nanhu-Nanling area should aid in providing employment for family members and education and employment opportunities for the children of those who are willing to take up residence in the area.

C. Personnel importing policies

Personnel are a key factor in building the high technology development zone. There will be no breakthroughs in construction of the Nanhu-Nanling area without rather attractive personnel importing policies. The Nanhu-Nanling area should become a paradise for all categories of S&T personnel, management personnel, and risk-taking entrepreneurs. The Nanhu-Nanling area should provide opportunities for them, particularly for middle-aged and young S&T and management personnel, to satisfy their business aspirations and competitive desires.

A hiring system, contract system, concurrent appointments, and other methods can be used for S&T personnel and administrative management personnel who come to work in the Nanhu-Nanling area. Their original units should not neglect wage increases, allocation of residences, and other aspects of welfare and treatment for personnel with concurrent appointments.

All high technology enterprises which meet the standards of administrative departments in the Nanhu-Nanling area have the authority to determine the wage and bonus standards for employees of their own unit. Moreover, they are exempt from collection of the bonus tax for a period of 5 years

and a reduction of one-half in the bonus tax for 6 to 10 years after the enterprise begins operating.

When S&T personnel and management and marketing personnel join together to come to the Nanhu-Nanling area to establish high technology enterprises, they should immediately approve registration and an industry and commerce registration after examination and approval by administrative departments in the Nanhu-Nanling area.

D. Taxation policies

The high technology products produced through operations by all high technology enterprises built with Chinese and foreign investments which meet the special technical standards of administrative departments in the Nanhu-Nanling area are exempt from taxes for 5 years from the day they begin sales or provide labor services and have a one-half reduction in taxes for 6 to 10 years.

Excluding those sent abroad, the profits to visiting businessmen from high technology enterprises in the Nanhu-Nanling area established with joint Chinese and foreign investments are exempt from taxes. The structural materials, production equipment, raw materials, parts, components, communications tools, and office products imported to the Nanhu-Nanling area for its own use are exempt from the unified industry and commerce tax.

With the exception of products whose export is prohibited by the state, export products produced by high technology enterprises in the Nanhu-Nanling area are exempt from the unified industry and commerce tax. Tax exemptions also can be given for domestic sales of products which are urgently needed within China.

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1989-1995 Development Policy of Integrated Circuit Industry

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[Article by reporter Li Qiongrui [2621 8825 3843]: "Ministry of Machine Building and Electronics Proposes Development Strategy for China's Integrated Circuit Industry--Accelerate Base Area Construction, Form Scale Economy Production, Focus on Developing Special Purpose Integrated Circuits"]

[Text] Known as the "food" of the electronics industry, how can integrated circuits which are the nucleus of microelectronic technologies be developed quickly in China? Recently, the Ministry of Machine Building and Electronics proposed the development strategy and overall deployments for China's integrated circuit industry for 1989 to 1995 of "accelerate base area construction, form scale economy production, focus on developing special purpose integrated circuits, and invigorate China's integrated circuit industry."

According to the formulated development strategy and deployments, the urgent tasks in development of China's integrated circuit industry are good base area construction and support for key and backbone enterprises to quickly form them into a scale economy.

For the next 5 or 6 years, integrated circuits in China will focus mainly on fully utilizing both Chinese and foreign resources, orienting toward both Chinese and foreign markets, actively developing large amounts of broad-based medium and large-scale circuit production, reinforcing integration with complete units, expanding market shares, and developing toward true establishment of an integrated circuit industry. In the area of technical development, design and product development will be reinforced, research on CAD technologies will be reinforced, and some forces will be organized to study 1 µm and sub-µm technologies and gallium arsendie integrated circuits to catch up to advanced world levels. On the basis of these strategic principles, China's integrated circuit industry will further transform the past ideology of focusing on technology tracking and take steps toward a market-oriented and scale economy.

At the experts conference held in Wuxi from 15 to 18 Feb 89, State Council member and Minister of the Ministry of Machine Building and Electronics Zou Jiahua [6760 1367 5478] pointed out issues to consider in development of integrated circuits:

1. Development of integrated circuits should begin with users and orient toward markets and use this to promote improvement of integrated circuit technologies, improvement of management levels, and improvement of personnel quality, and cannot consider questions solely in terms of the development of integrated circuits themselves;

2. The primary focus in development of integrated circuits should be placed on ourselves while at the same time striving to import advanced foreign technologies and raise the starting point of development;

3. Forces of the entire industry should be organized and integrated to make full use of existing forces within China without rebuilding many new points;

4. Reinforce research on integrated circuit CAD technologies and development of new integrated circuit products;

5. Equipment, instruments, and materials should be coordinated with development of scientific research and production of integrated circuits;

6. Plants should give special emphasis to product quality, product completion rates, and reliability questions. At the same time, they should reinforce propaganda, marketing, and extended applications work for Chinese-made circuits.

The development path of China's integrated circuit industry has been a very difficult one and after more than 20 years of struggle, particularly during importing and technical transformation during the Sixth 5-Year Plan and development during the Seventh 5-Year Plan, China's integrated circuits have made noticeable achievements and we now produce about 100 million pieces annually. More than 1,000 product varieties are now being produced and a relatively concentrated production and scientific research base area has taken shape which has several backbone enterprises and a workforce with definite technical strengths. All of these things have laid a beneficial foundation for China's integrated circuits to step up to the stage of scale economy. Of course, China should acknowledge that domestic and foreign markets for integrated circuits are extremely broad, whereas our products at present account for just one-third of our domestic market and less than 1/300th of total world output. Moreover, most of China's plants which produce integrated circuits use 3-inch silicon chips and 5 μm technologies to produce integrated circuits which are generally medium and small-sized. Large scale and super-large scale circuits depend almost entirely on imports. In contrast, Japan, which began at the same time as China, South Korea, which began 7 to 8 years later than China, and even Taiwan Province which took its first steps 10 years after China, have an enormous lead over us in the area of integrated circuit production. It is difficult for China's integrated circuits to compete with their products in output, product varieties, quality, and equal quality and equal price. We have already changed to a situation of

"getting up early and going to the fair late." Thus, we can brook no delay in forming industrialized large scale production of integrated circuits in China and moving up to a new stage.

The integrated circuit industry is a strategic industry which plays an enormous role in national economic construction, national defense construction, and in the development of modern science and technology, the transformation of traditional industries, and promoting social progress. It not only transforms man's production patterns along with computers, communications equipment, industrial automated equipment, all types of instruments, and so on, but also continually transforms man's living patterns by entering the homes of common people via televisions, receivers and recorders, video recorders, electronic watches, electronic musical instruments, electronic toys, and other things. Still, integrated circuits themselves are a high technology industry as well as a micro-profit or no-profit industry. Thus, the unanimous opinion of the experts at the meeting was that in developing this industry, besides clear goals and proper plans, a spirit of hard work by personnel, and other factors, the state must provide the corresponding support policies and provide specific investment strengths. Without attaining a certain threshold value of investment, the formation of large scale production and formation of scale economies are impossible.

China's First Submarine-Launched Ballistic Missile Test Described

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[Article by Liu Shaoqiu [0491 4801 3808] and Lu Zheng [7120 6154]]

[Excerpts] On an autumn day in the late 1950's, a large, white cylinder rose from the Pacific Ocean and headed straight toward the sky, leaving a long trail of flame and smoke behind. A short time later, its nose section fell back to the ocean over 1,000 km away. This even rocked the news media and appeared on the front page of every major newspaper.

This giant cylinder was the world's first submarine-launched ballistic missile (SLBM) developed by the United States, the "Polaris" Al.

More than 20 years elapsed. In October 1982, China announced to the world that it was ready to launch the first Chinese-built submarine-launched ballistic missile. China was to become the fifth country in the world to possess SLBM's.

The Years of Struggle

The SLBM is a ballistic missile launched by submarines submerged in deep oceans for attacking ground-based strategic targets. The superpowers call the submarine-launched ballistic missile, the inter-continental ballistic missile (ICBM) and the long-range strategic bomber the "triad" of strategic weapons; in fact, they believe that the SLBM is the most important and effective strategic threat. For this reason, the SLBM is treated by the superpowers as the jewel of their strategic arsenal. [passage omitted]

In the early 1960's, with very little knowledge and working in an environment of closely guarded foreign technology and a primitive chemical industry, young Chinese scientists and engineers proceeded to develop China's own solid propellant in poorly-equipped laboratories. After numerous failed attempts, they finally succeeded in making the first propellant-column the size of an ordinary fountain-pen.

At that time, the two superpowers were engaged in a fierce arms race; ICBM's were being built one after another. During this period, China was encountering a great deal of economic difficulties, but it decided to proceed on the course of developing a 300-mm solid-propellant rocket engine.

After years of struggle and searching in the dark, Chinese scientists and engineers were able to solve a number of difficult problems such as cracks in the propellant-column and combustion instability, and finally succeeded in building the first batch of 28 solid-propellant engines. They also conducted vibration tests, impact tests, storage tests and ground firing tests, and ultimately selected 6 engines for flight tests. The test results showed that the Chinese-built solid rocket engine was structurally reliable and operationally stable, and its performance met all the design requirements.

The successful development of this small engine was a very important step in the history of solid rocket engines in China; it laid a solid foundation for the subsequent development of large and medium size engines. However, its development was not without cost; many of its creators contributed their sweat and blood for this small engine. For example, on 6 December 1962, during the process of loading propellant into the 300-mm engine, an explosion occurred, killing four technicians.

In late 1965, in response to the need to build a solid-propellant ballistic missile, efforts were initiated to develop a large solid rocket engine. However, a difficult problem was encountered: the heat treatment furnace did not have adequate capacity to accommodate a larger engine. Fortunately, this difficulty was overcome by using an ingenious "segmented quenching" technique. Soon the first large engine was successfully built and tested.

In 1967, a directive to build a solid-propellant ballistic missile was issued by a special State committee. The first and second stages of the missile would be propelled by solid rocket engines. In order to allow the flight control system to control the missile flight path, the solid rocket engines would have to be equipped with a device to control the thrust magnitude and direction; this required the use of new swivel nozzle [gimdal] technology.

Because of the difficulties encountered in developing new materials and new propellants, and in solving a variety of design problems, and because of the lack of advanced research techniques and test equipment, initial progress was very slow. It was not until 1976 that the situation improved significantly. Shortly thereafter, the first and second stage engines were developed. The birth of the solid rocket engine laid the foundation for future development of China's solid-propellant missiles.

Successful Flight Tests

Historically, the development of strategic missiles had always followed the course from single stage to multiple stages; but we skipped the single-stage development and proceeded directly to the two-stage missile, we also skipped the ground-based missile and proceeded directly to develop the submarine-launched solid-propellant missile. This was a bold and difficult decision. Because of the limited space in a submarine, the solid-propellant SLBM must be considerably smaller than a land-based liquid-propellant missile. Consequently, the instruments onboard the missile must be miniature and very light in weight; also, special considerations must be given to the

design of various onboard systems so they can survive the underwater environment when the missile is launched from below the ocean's surface. Many of these design problems involve considerable technical difficulties that can only be overcome after extensive research.

What is the motivation for building an SLBM? It is well known that ICBM's are the prime targets in a strategic war; they are particularly vulnerable today because the missile launch sites and the underground silos can be easily detected by overhead reconnaissance satellites. An obviously safe place to conceal the missile is in a submarine, which can cruise beneath the water under the protection of the vast ocean. Furthermore, it can launch upon command a surprise attack against enemy strategic targets such as weapons factories, military facilities, missile silos and political or financial centers. Therefore, the marriage between submarine and missile has created a powerful strategic force for national defense.

The development of an SLBM normally requires a series of tests on the ground and underwater prior to the submarine launch test. However, in China's SLBM program, we proceeded directly to the submarine launch test after only the launch-pad test and the launch-tube test. In 1979, prototype design of all the subsystems had been completed, and acceptance tests of the subsystems had begun; finally, the entire missile was assembled and ready for flight test.

On 17 June 1981, after years of hard work and struggle, the assembled solid-propellant missile finally arrived at the launch pad. Following the launch command, the missile rose from the pad and headed toward the sky. This successful flight test opened a new page in the history of China's solid rocket development.

On 7 January 1982, a launch-tube flight test was conducted. During this test, the missile was placed in a launch-tube which was in a missile silo. When the launch command was issued, the gas generator was ignited, ejecting the missile out of the silo. Upon ignition, the missile began to climb and shortly disappeared into space. On 2 April 1982, another launch-tube test was successfully conducted.

With three consecutive flight tests successfully completed, the missile was not ready for the underwater submarine launch test.

The Flying Dragon

The first underwater flight test of China's solid-propellant missile was set on 12 October 1982. On this fall morning, the sky was clear and there was a gentle breeze. All test personnel converged on this military harbor. Ships and helicopters were busy collecting hydrological and meteorological data in the launch area. The submarine carrying the solid-propellant missile sliwly left the harbor, accompanied by a fleet of escort ships and observation vessels. A short time later, this convoy arrived at the launch site.

The Captain issued a "Dive" command, and the submarine began to submerge.

Then the countdown began. At 5 minutes to launch, the cover of the launch tube was opened; at 1 minute to launch, the engine safety latch was released, and the launch control light was turned on. Finally, the Captain issued the launch command. Instantly, the missile was ejected from the launch tube, and, like a dragon, pierced the ocean, pulling with it a column of water tens of meters high; once in the air, it flew straight toward the designated region in the open sea.

China's Broadcast Communications Satellites Reviewed

40080203 Shanghai DIANXIN KUAIBAO [TELECOMMUNICATIONS INFORMATION] in Chinese No 5, May 89 pp 2-7

[Article by Chen Daoming [7115 6670 2494]]

[Excerpts] Since China launched its first artificial earth satellite on 24 April 1970, it has successfully launched three geosynchronous communications satellites: the first was an experimental communications satellite, the DFH-2, which was launched on 8 April 1984 and stationed at 125° E. longitude on 16 April; the second was an operational broadcast communications satellite, the DFH-2, which was launched on 1 February 1986, and stationed at 103° E. longitude on 16 February; and the third was the operational broadcast communications satellite, DFH-2A, which was launched on 7 March 1988 and stationed at 87.5° E. longitude on 22 March. These satellites have been fully tested in orbit and are currently bringing television and communications services to China's remote areas and mountainous regions. The onboard equipment of the first Chinese communications satellite, launched [over] four years ago, is still operating normally.

In this article, a brief summary of the current status of China's communications satellites is presented; in particular, the technical parameters of the satellite payload, i.e., the communications transponders, are described in detail. In addition, a projection of the future prospects of the next-generation high-capacity communications satellites is also given.

1. Introduction [Passage omitted]

Since China successfully launched its first artificial satellite on 24 April 1970, it has developed and launched 24 different types of satellite. In the early 1970's, China conducted feasibility studies and preliminary research toward developing its first experimental communications satellite. After 1975, the scope of this work was expanded and the pace was accelerated; specific accomplishments included developing the communications satellite itself and the "Long March-3" launch vehicle, constructing the Xichang

launch site and the tracking and control station, as well as the supporting ground stations. In addition, three communications satellites were successfully launched, and various in-orbit tests and communications experiments were successfully carried out, which included tests on television, broadcast, telegraph, telephone and facsimile transmissions. These satellites made it possible for the citizens of Xinjiang and Tibet to receive central television broadcasts from Beijing; they also solved the communications problem between these remote areas and China's interior regions. Today, there are more than 5,000 television receive-only [TVRO] stations in operation, which can provide television coverage to over 70 percent of the Chinese landmass. Currently, the satellites are scheduled to broadcast two channels of Central Television programs and one channel of educational programs nationally. It is expected that by the end of 1988, a second channel of educational programs will become available, which will significantly enrich the cultural life and raise the educational standard of China's population.

The three communications satellites which are currently in orbit include two first-generation satellites and one satellite with improved design. The two first-generation DFH-2 satellites were experimental communications/broadcast satellites, whereas the improved DFH-2A is an operational satellite. A schematic drawing of the satellite is shown in Fig. 1. The three satellites are all spin-stabilized cylindrical bodies; the cylinder is 1.6 m high and 2.1 m in diameter. The frequency band used by the satellites is C-band, 6/4 GHz. The DFH-2 satellites are each equipped with two 8-watt (output power) traveling wave tube amplifiers (TWTA); the DFH-2A satellite is equipped with two 10-watt (output power) TWTA's and two 10-watt field-effect solid-state [power] amplifiers (SSPA). The antennas on the three satellites are also different: the first satellite uses a global-beam antenna; the second satellite uses an antenna which covers only the Chinese landmass and provides a beam-peak EIRP [effective isotropic radiated power] of 35.1 dBW; the third satellite also uses an antenna covering the Chinese landmass, but its EIRP is further increased due to the enhanced power output of the amplifier and the improved performance of the antenna feed system. The characteristics of the three satellites are summarized in Table 1.

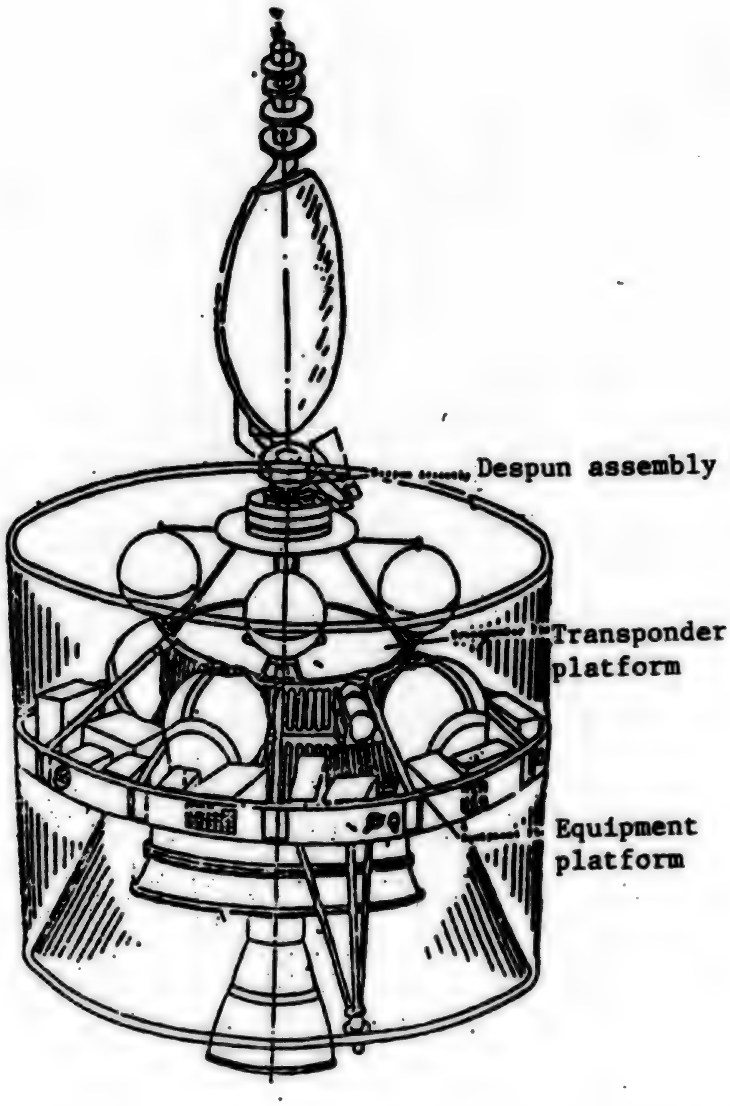


Fig. 1 Schematic Drawing of the DFH-2A Satellite Exterior

Table 1. China's Broadcast Communications Satellites

Satellite		DFH-2		DFH-2A
Name		DFH-2		DFH-2A
CCIR regn. No.		STW-1	STW-2	CHINASAT-1
Launch date		1984.4.8	1986.2	1988.3.7
On-station date		1984.4.16	1986.2.16	1988.3.22
Station location		125°E	103°E	87.5°E
No. of transponders		2	2	4
Power amplifiers		2 TWTA	2 TWTA	2 TWTA, 2 SSPA
Amplifier output power		8W each	8W each	10W each
Antenna beam		Global	Domestic	Domestic

2. Payload

The heart of a communications satellite is the payload, which includes the transponders and the antenna. Its main function is to transpond the received communications signals and to separate the remote-control and ephemeris tracking signals and send the information back to the ground tracking and control network. It also transmits the data on engineering and physical parameters of the onboard equipment to the ground by synthesizing the telemetry and the ephemeris-tracking signals. Since the signal level received by the satellite is only of the order of 10^{-9} watt due to propagation losses over a distance of more than 36,000 km, the transponders must have the capability to provide low-noise amplification, power amplification, and gain adjustment in order to raise the signal level; its net gain must be approximately 110 dB. To achieve an amplification factor of this magnitude, the transponders must have frequency-shift capability to avoid system instability caused by co-channel interference and interference due to secondary harmonics and inter-modulation. In addition, the input and output of the transponders must have good filters to reduce the out-of-band interference with neighboring satellites or other communications networks.

A communications satellite is a multiple access communications system which performs simultaneous amplification of multiple carriers which enter the transponders. This requires that the non-linearities of the transponder components must be kept to a minimum; any non-linearities in the system will severely degrade system performance. On the other hand, because of the limited energy sources onboard the satellite and the requirement of high-efficiency operation for its components, many components must operate in the non-linear region. These contradictary design requirements must be carefully considered by the designer.

China's communications-satellite transponder design is now in its second generation. The first-generation DFH-2 transponder is frequency-shifted via a double frequency-conversion process; the 6-GHz uplink signal from the ground is first down-converted to Intermediate Frequency (I.F.), which is then up-converted to a 4-GHz downlink signal. The reason for this design was to provide high-gain, narrow-band channels for some of the small ground stations which only had limited-size antennas back in the early period of China's experimental communications networks; these channels are easier to realize in the I.F. range. The second-generation DFH-2A transponder is frequency-shifted via a single frequency-conversion (or microwave frequency conversion) process; the 6-GHz uplink signal transmitted from the ground is directly down-converted to a 4-GHz downlink signal. By using this microwave-microwave frequency-conversion design, it is possible to simplify the system structure, reduce the number of components, and improve its reliability.

China's communications satellites use two tracking beacons. There are two considerations that affect the configuration of the beacon system: (1) The two beacon signals produced by the beacon generator are amplified separately by the two TWTA's; this provides a back-up capability which improves the reliability of the beacon system. On the first-generation satellite, the assigned frequency of the beacon signal was below the communications band; this resulted in a very complex output multiplexer design. (2) During the launch phase, a low-gain, omni directional antenna is used to transmit the beacon signal, hence it requires the total output power of the TWTA. When the satellite is on station, a high-gain, directional antenna is used for transmission, hence only a fraction of the TWTA output power is required to achieve the same EIRP; the required power is determined by the difference in gain between the two antennas. Therefore, one must adjust the excitation voltage from the beacon generator to the TWTA when different antennas are used.

2.1 DFH-2 Communications Transponder

The block diagram of the DFH-2 communications transponder is shown in Fig. 2.

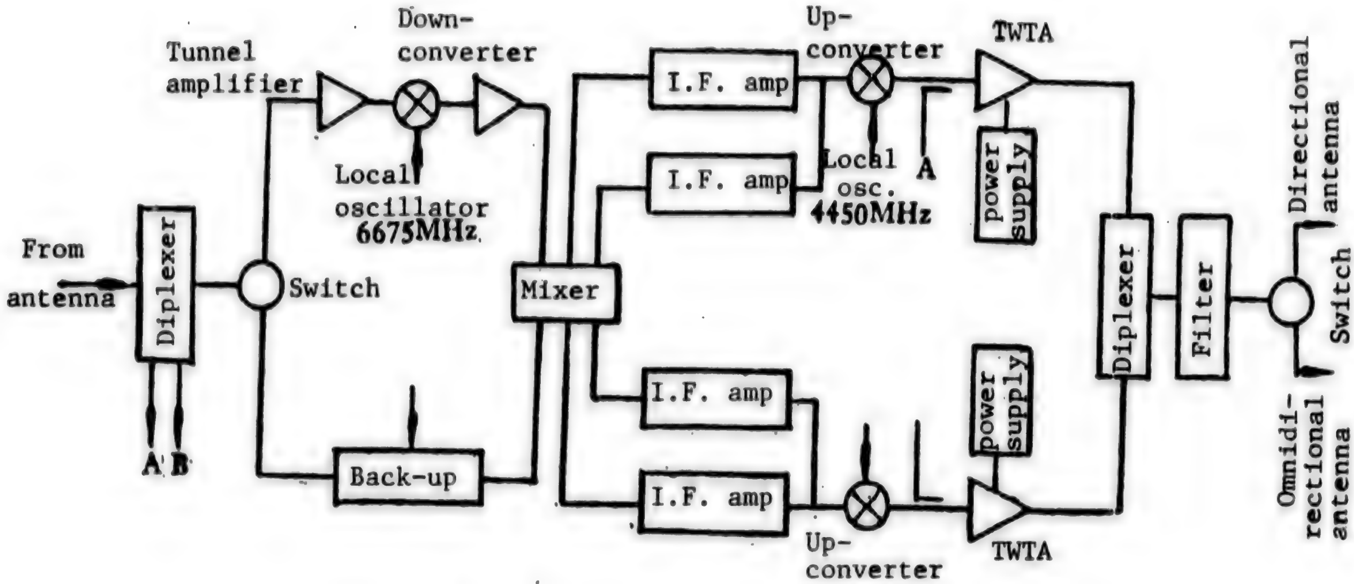


Fig. 2 DFH-2 Communications Transponder

The received communications signal from the ground station first passes through a diplexer, where the uplink signal is separated and sent to a tunnel-diode low-noise amplifier via a switch. It is then pre-amplified and down-converted to I.F., and sent to the primary I.F. amplifier after I.F. pre-amplification. The primary I.F. amplifier has a frequency division network which divides the input signal into a narrow-band channel and a wide-band channel. Both channels have high gains that can be controlled in steps by ground commands to meet the requirements of in-orbit tests and communication experiments. But the two channels have different gains: the gain of the narrow-band channel is 6 dB higher than that of the wide-band channel. After the signal is amplified in both the narrow-band and wide-band channels, it is re-combined and up-converted to the 4-GHz downlink frequency. The up-converter has a directional coupler which synthesizes the signal with the beacon signal from the beacon generator; the synthesized signal is amplified by the TWTA to the required microwave power level. The output signals from the two TWTA's are synthesized in the output multiplexer, and filtered by a harmonic band-pass filter, then transmitted via a directional antenna to the ground.

In order to ensure reliable operation of the transponder, the onboard receiver segment (the tunnel amplifier, the down-converter, and the I.F. pre-amplifier) and the local-oscillator segment (the crystal oscillator, the frequency multiplier, and the power amplifier) all have back-up units which can be switched into operation by ground command. In-orbit operation over the

past four years show that these units are quite reliable. Except during the in-orbit test period, the back-up units have never been used in actual operation.

2.2 The DFH-2A Communications Transponder

The DFH-2A communications transponder uses microwave frequency conversion; its block diagram is shown in Fig. 3.

The communications signal is received through a directional antenna, and is filtered by the diplexer filter to extract the uplink signal. It then enters the wide-band low-noise receiver where it is amplified and down-converted to the 4-GHz downlink frequency, then further amplified by the field-effect amplifier for output. The signal is divided into four channels by the input multiplexer; each channel has its own voltage regulator, equalizer, and power amplifier which can be controlled from the ground; the single-frequency saturated power output of the amplifier is 10 watts. The four power amplifiers of the transponder consist of two TWTA's and two field-effect SSPA's. It can be seen from the block diagram that during launch, the beacon signal is amplified by the TWTA before transmission via the omni antenna. But, after the satellite is on station, the signal is amplified by the field-effect amplifier instead of the TWTA; it is then combined with the communications signal in the multiplexer and transmitted to the ground via the directional antenna. The beacon signal and the communications signal use separate power amplifiers to reduce mutual interference, and to minimize the design difficulty in achieving electromagnetic compatibility.

The wide-band receiver of the transponder has a back-up unit which can be controlled by ground command.

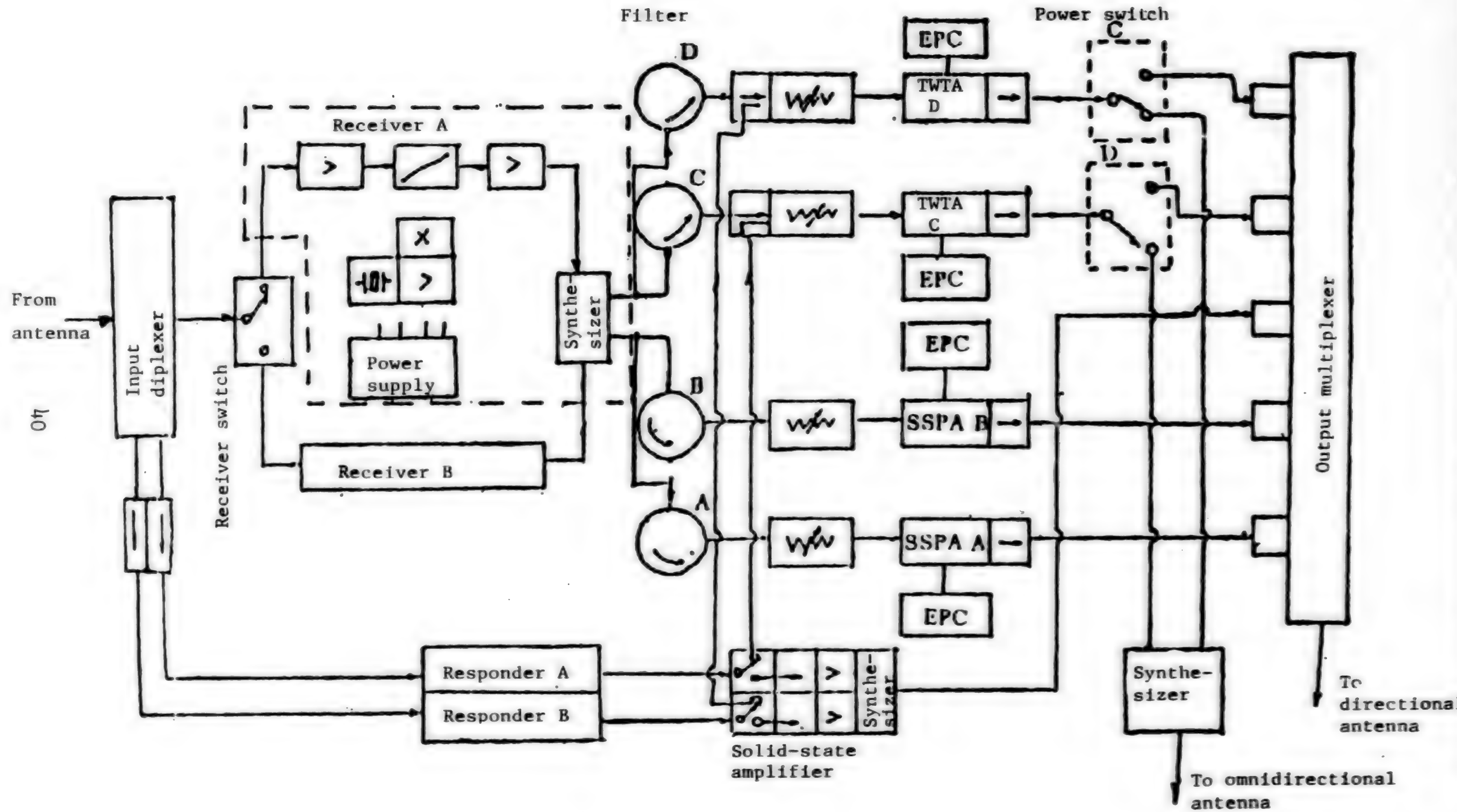


Fig. 3 DFH-2A Communications Transponder

3. Technical Specifications of the Transponder

All three of China's communications satellites operate in the C-band. The key technical specifications of the DFH-2 and the DFH-2A are listed in Table 2.

Table 2. Key Technical Specifications of the DFH-2 and DFH-2A

Satellite	DFH-2	DFH-2A
Uplink frequency (MHz)	6292-6421	6055-6421
Downlink frequency (MHz)	4067-4196	3830-4196
Frequency conversion (MHz)	2225	2225
Accuracy of frequency conversion	$\pm 6 \times 10^{-6}$	$\pm 6 \times 10^{-6}$
Beacon frequency (MHz)	4002 4023	4003 4022
Operating bandwidth (MHz)	2 x 49	4 x 36
Number of power amplifiers	2	4
Single-frequency saturated output power (W)	8	10
Third-order intermodulation (dB)	$>$ 10 (satrd.)	$>$ 10 (satrd.)
Frequency response (dB)	± 0.5	± 0.25
Overall noise figure (dB)	Better than 7.5	Better than 5

The total gain of the transponder should be determined according to the requirements of the satellite communications network. In particular, the capability of the communications network, the size of the ground stations, the C/N required to achieve the specified communication quality, the allowable bandwidth, etc., must be considered. In addition, the feasibility of achieving the specifications allocated for the various components of the transponder in order to meet the overall gain requirement must also be considered.

The up-converter in the channel has non-linear characteristics; when the signal level is too high, the up-converter provides a soft amplitude cut-off to prevent over-excitation of the TWTA; the maximum over-excitation is approximately 6 dB.

The transponder of the DFH-2A uses a low-noise wide-band receiver; the low-noise amplifier and the post-amplifier are field-effect solid-state amplifiers. The technical specifications of the receiver are listed in Table 3.

Table 3. Technical Specifications of the Wide-band Receiver

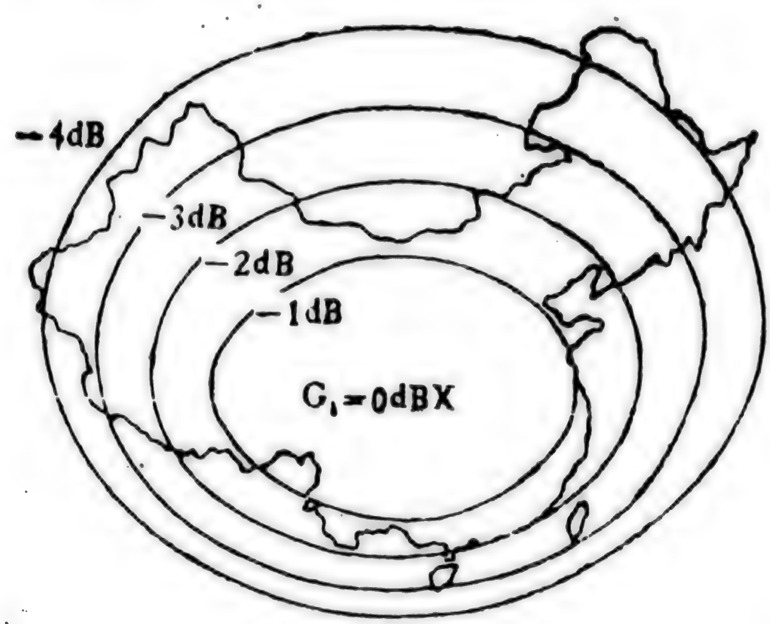
Parameter	Specification
Input frequency (MHz)	5925-6425
Gain (dB)	68.5 ± 0.5
Gain stability (temp. 0°C-50°C)	$\leq 1dB_{pp}$
Frequency response (500MHz)	$< 1dB_{pp}$
Frequency response (36MHz)	$0.2db_{pp}$
Gain slope (dB/MHz)	≤ 0.01
Noise figure (dB)	3.5
Input/output standing wave ratio	1.2
Group delay at 500MHz (ns)	3.0
Third-order intermodulation cut-off point (dBm)	$\geq +29$
Frequency conversion (MHz)	2225
Long-term frequency stability (10 years)	$\pm 5 \times 10^{-6}$
30-day frequency stability	$\pm 5 \times 10^{-7}$
Short-term frequency stability	$\leq 30Hz_{rms}$
Local-oscillator second harmonics (dBm)	< 30
RF overexcitation (dBm)	-35

Two of the four amplifiers are TWTA's; the other two are field-effect SSPA's with good linearity and high reliability. The characteristics of the SSPA are shown in Table 4.

Table 4. Ten-Watt Solid-State Power Amplifier

Parameter	Specification
Frequency	3.7-4.2GHz
Standard input level	-18dBm
Maximum input level	-5dBm (max. 24 hours)
Maximum output power	10W (40dBm)
Maximum input standing wave ratio	< 1.25 (when f=3.7-4.0GHz) < 1.3 (when f=4.0-4.2GHz)
Standard output standing wave ratio	< 1.2
Noise figure	$< 10dB$
Single-carrier gain	min. 56dB (saturation point) min. 61dB (at 1W output power)
Gain variation (in any 40MHz band)	$< 0.2dB_{pp}$ (saturation point) $< 0.4dB_{pp}$ (at 1W output power)
Gain slope	max. ± 0.01dB/MHz (saturation point) max. ± 0.02dB/MHz (at 1W output power)
Gain stability	$0.5dB_{pp}$ (at high signal level) $0.8dB_{pp}$ (at low signal level)
Third-order intermodulation products	-16dB (corresponds to the output power of the two carriers at saturation level)
Standard dc power consumption	28-43V 44W

The two DFH-2 satellites have different antennas; the first satellite uses a global-coverage antenna while the second satellite uses a domestic-coverage antenna. The two have different gains; the EIRP differs by about 10dB. The isograms of the antenna gain are shown in Figure 4. Based on the gain values in the figure, one can calculate the EIRP.



(a)

Fig. 4(a) Isogram of Antenna Gain for the First Experimental Comsat

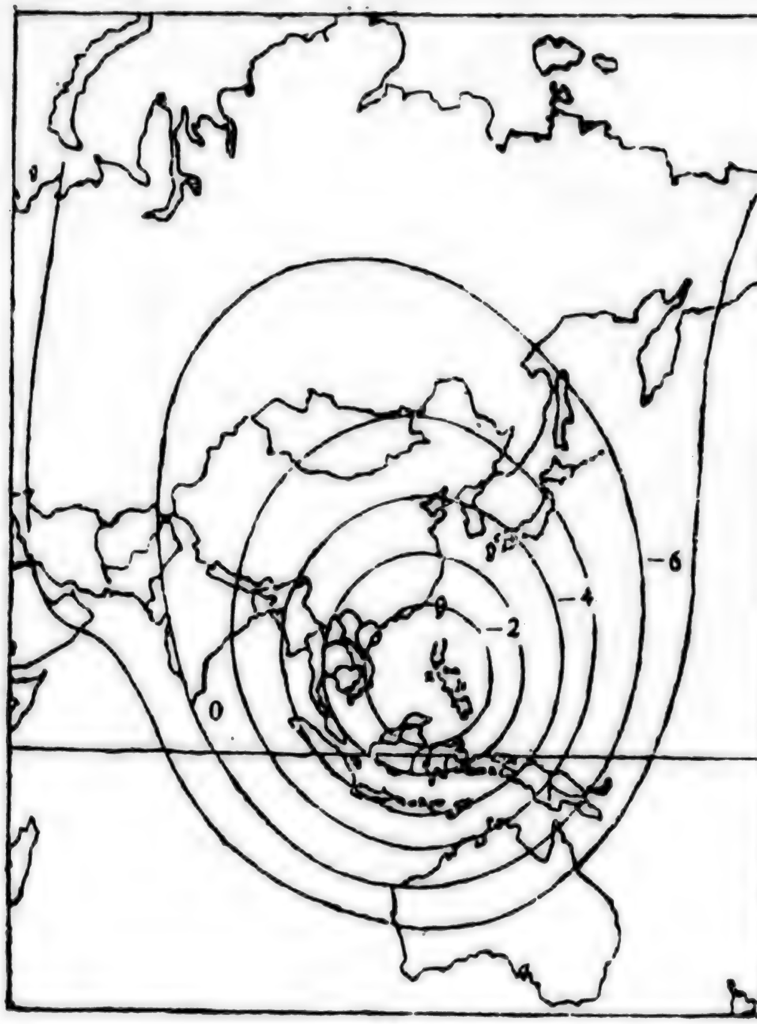


Fig. 4(b) Isogram of Antenna Gain for Second Experimental Comsat

4. Concluding Remarks

Toward the final stages of development of the DFH-2 experimental satellite, efforts were initiated to develop an operational satellite (the DFH-2A). Based on the experience gained from building the DFH-2, research and feasibility studies were carried out to increase the number of transponders, and to explore ways to extend the design life of the satellite. As a result, significant changes were made in the power supply, structural weight, and transponder design. Today, the DFH-2A satellite has been successfully launched; its in-orbit tests and transmission experiments have produced satisfactory results, and all on-board systems are functioning normally. Since 20 April 1988, it has been nationally broadcasting all three channels of television programs as well as providing communications services.

The three satellites launched over the past four years have provided cumulative valuable experience for China's communications satellite program. Specifically, quality assurance techniques and environmental test methods have been developed as part of the effort to explore long-life, high-reliability satellite components. Currently, China has several thousand TVRO's, and is also devoting considerable resources toward construction of communications ground stations. The proliferation of ground stations and the expanded use of satellite communications in turn place additional demands on communications satellites. For this reason, efforts have been initiated to study the feasibility of developing a high-capacity broadcast communications satellite, the DFH-3. This is a third-generation satellite which uses three-axis stabilization and has enhanced capacity and improved quality. It is expected that this new system will be able to satisfy China's communications and television broadcast needs for the next decade.

The main features of this satellite are as follows:

--It has six television broadcast channels; its maximum EIRP within the Chinese territorial boundry is about 37.5 dBW.

--It has 18 communications channels, with a maximum EIRP of approximately 34.5 dbW.

--It uses a double-grid parabolic antenna, with provision for frequency multiplexing; the total effective bandwidth is 864 MHz.

--The frequency band is 6/4 GHz.

--Expected launch date: 1992.

Its electrical specifications are as follows:

television-channel power amplifier	TWTA
single-frequency saturation output power (each amplifier	16 W
back-up configuration	9:6
communication-channel power amplifier	SSPA
single-frequency 1-dB compression output power (each amp.)	8 W
receiver back-up configuration	4:2
uplink power density	-88 dBW/M^2

Research Trends at the First Institute of 'Second Artillery'

40080193a Beijing KEJI RIBAO [SCIENCE & TECHNOLOGY DAILY] in Chinese 26 May 89 p 2

[Article by Xu Lianyue [1776 6647 6460] and Chen Shouqin [7115 0649 4440]]

[Excerpts] Recently, a new product from the First Institute of the 'Second Artillery,' "contamination-proof cookware for use in underground tunnels," passed certification. This was the 50th new product of research and development by young scientists and engineers at the Institute.

Since its establishment in 1983, the Institute has accepted 42 students who graduated from both military and non-military colleges and graduate schools. To help them adapt to the research environment at the Institute, the young students were assigned research tasks under the guidance of older scientists. [passage omitted] The Institute also offered the students assistance in solving their personal problems, and provided them with the opportunity to assume major responsibilities in their work. For example, the "computer-automated measurement and control" (CAMAC) technology was a new technology imported from abroad in the early 1980's. Young engineers Yu Huaifa, Jia Sheng, Zhang Chaoying and Liu Hui took the initiative to develop an automated missile tracking and control system using micro-CAMAC technology [see also FBIS-CHI-89-026, 9 Feb 89, pp 15-16]. To carry out this task, they devoted a great deal of effort in collecting information from available literature and in soliciting ideas from staff members of the 'Second Artillery' and other organizations of the former Ministry of Astronautics Industry; they also introduced innovative ideas by combining modern microprocessors and manual computational techniques, and overcame difficulties encountered in data debugging and in long-line transmission. During the development process, several comrades had turned down high-pay job offers and the opportunity to pursue graduate studies or to earn advanced degrees; some even postponed getting married in order to devote [their energies] to their jobs. After 7 years of dedicated research, they finally succeeded in realizing their long-cherished wish for an automated missile-launch tracking and control system integrating modern high-tech microcomputer systems and international-standard-interface CAMAC [technology].

Another example involved the attempts by young scientists Zhou Kun, Liao Yuning and Kang Ningmin to solve the problems associated with missile launch: optical interference, signal overload and instability during long-distance transportation. By conducting research and investigation in close coordination with military personnel, they were able to develop a missile parasitic-light-rejection signal device, an electronic overload test probe for missiles, and an instability warning device for missiles. Last year, the 'Second Artillery' organized a large-scale position debugging test, during which assistant engineer Li Yi single-handedly removed 12 obstacles to allow the test to proceed smoothly. [Passage omitted]

Aviation Industry Supplying Parts for Export

40080193b Beijing KEJI RIBAO [SCIENCE & TECHNOLOGY DAILY] in Chinese 25 May 89 p 2

[Article by Zheng Qianli [6774 0578 6849]]

[Text] In recent years, China's aviation industry has devoted considerable resources to the production of aviation parts for export. This new venture has provided the incentive for technical reforms and for improving the technical and management standards of China's aviation industry. It has also contributed to the development of China's short-range commercial airplanes and has generated benefits in areas such as production, technology and economy. Because of the ready access to foreign aviation technology, we have become familiar with and have adapted to the current standards and manufacturing techniques of foreign commercial aviation; we have also acquired guidelines for implementing technical reforms and improving management standards for our own aviation industry. Also, production of aviation parts involves very little market risk because it is based on orders placed by customers; the economic benefits derived from the exports can solve the problem of tight foreign reserves and provide the badly needed funds for importing new technologies and new equipment.

To produce aviation parts for export, the Ministry of Aviation Industry in recent years has established clearly defined policies, an export production system, and a system for export management. Since 1986, the export volume has been continually increasing, and the scope has been expanding. In 1988 alone, the total export output value was $US53.13 million, which exceeded the target for the year, and established a record for subcontract production of aviation parts.

Today, the Ministry of Aeronautics and Astronautics Industry has more than 10 airplane factories, engine factories and onboard-equipment factories which, under a compensation trade agreement, have signed more than $US100 million worth of parts contracts with the United States, Great Britain, France, Italy, Sweden, Canada, and the FRG. The parts under production for various types of commercial aircraft include cargo doors, center wings, ailerons, vertical tails, engine parts, gear boxes, guide vanes, combustion liners, compressor discs, turbine discs, and forged parts. Because of the reputation for high-quality parts, many foreign aircraft companies have issued award certificates and plaques to the Chinese industry.

In addition to its expanded role in export production, the aviation industry has also implemented reforms in many technology areas such as numerically controlled machine tools, modern heat-treatment techniques, composite materials and non-metallic materials, new measurement techniques and new physical and chemical test/detection methods. These reforms are helping [Chinese] firms catch up with state-of-the-art technological levels.

It is reported that export of China's aviation parts will continue to expand in the future. The overall plan is to achieve the following three-stage goal: in 1990, the subcontract export output value is expected to be between 30 million dollars and 100 million dollars per year; during the "Eighth 5-Year Plan," all major engineering firms are expected to become qualified contractors; and by the end of the "Ninth 5-Year Plan," the annual export gross output value is expected to reach 300 million dollars. Furthermore, export production will expand from small aviation parts to large parts such as wings and fuselages, and will be integrated with the manufacturing of China's short-range commercial airplanes into a single production system.

U.S. Firms Plan To Launch TV Direct Broadcast Satellites via Long March Booster

40080211a Beijing DIANZI SHICHANG [ELECTRONICS MARKET] in Chinese 1 Jun 89 p 3

[Article by Xing [5281]: "China's Long March Booster to Launch First TV Direct Broadcast Satellites for U.S."]

[Text] Two U.S. firms, the SSTI Company and the DVSI Company, plan to launch their first group of two television direct broadcast satellites (DBS) into space via China's Long March launch vehicle in August 1989.

The U.S. firm DVSI will invest US$90 million to cover the expenses of launching these two TV DBS's. The SSTI Company will be responsible for the launch and check upon delivery, and will enter into a corporate venture with the DVSI Company about 3 months after the satellites reach orbit; it will directly transmit the [TV] programs to each family in the U.S.

High-Capacity Comsat To Be Launched

40080212 [Editorial Report] Beijing KEJI RIBAO [SCIENCE & TECHNOLOGY DAILY] in Chinese of 28 Jun 89 carries on page 1 a 400-word article (released in Beijing on 27 June through XINHUA) covering the China Broadcast Satellite Corporation's (CBSC) announcement that China will launch a high-capacity operational communications satellite--the "Dongfang Hong 3" (DFH-3)--at the end of 1992. The satellite, which will be used for domestic telecommunications and for transmitting television programs, will have 24 transponders which can simultaneously carry six circuits of color TV programs and 15,000 circuits of telephone, telegraph, facsimile, and data signals.

Additional details not published in an earlier report (see FBIS-CHI-89-128, 6 Jul 89, p 57) on this topic follow. The area of coverage will be the entire nation, including all of China's South Sea islands. Based on the need for developing domestic satellite communications systems, some time after the launch of the DFH-3, China will launch a completely identical satellite, the DFH-3B, which will be fixed into a different orbit. When the two satellites are simultaneously used for communications, therefore, they will be able to simultaneously carry a total of 12 circuits of color TV programs and 30,000 telephone and/or other circuits. The satellite, which will incorporate advanced technologies meeting international standards of the early eighties, is being built by scientific research and production units under the Ministry of Aeronautics & Astronautics Industry with broad cooperation from several foreign countries; it will be launched with China's Long March 3A booster. With funding from the state, the satellite is being developed and will be launched via the contract responsibility system. After the satellite becomes operational, CBSC will assume management, and will lease the circuits via contract to users in various departments such as broadcasting, television, posts & telecommunications, and education. Operating income will be reinvested in development of comsat services.

New Nickel Electrode Aids Ceramics

40080211b Beijing ZHONGGUO DIANZI BAO in Chinese 13 Jun 89 p 3

[Article by Miao Jiahua [4924 1367 5478] and Duan Hongwu [3008 4767 2976]: "Plant 4322 Develops Atmospherically Sintered Nickel Electrode Material Process"]

[Summary] Kunming Plant 4322 has recently promoted a Ni-Ag-C-2 and Ni-C-1 series of nickel electrode materials. These atmospherically sintered materials open a new path for domestic development of ceramic products used in electronics.

Conventional electronic ceramic products utilize silver as the electrode material. Much research worldwide has been conducted into new methods--such as chemical plating and sintering in a nitrogen gas--for replacing silver with nickel, but these processes have proved difficult to apply. Now, Plant 4322, using a special process, has overcome the difficulties in atmospheric sintering of nickel. The new nickel electrode material has a solid-state composition greater than or equal to 70 percent, a solid-state grain size of 0.32 micron, and a thick-material [dynamic] viscosity of 3600-4400 poise. The sintering temperature can be regulated up to 800°C, and the resistance temperature coefficient is +1500 to +3300 PPM/°C [parts per million per degree Celsius]. Sheet resistivity is less than or equal to 60mΩ/□ [milliohms per square], and for ceramic capacitors, it is 30-20mΩ/□; loss is 1-2 percent. Vertical pulling force is 10N [newtons] and horizontal pulling force is 30N. The material's technical indicators match those of a similar nickel electrode material (which requires a sintering temperature of 900°C) made by the U.S. firm DuPont.

At present, this material has applications in piezoelectric ceramic peak resonance chips, two varieties of ceramic capacitors, NTC [negative temperature coefficient] and PTC [positive temperature coefficient] thermistors, and plasma displays.

Anthology on Artificial Neural Networks and Knowledge Systems

40080186b Shenyang XINXI YU KONGZHI [INFORMATION AND CONTROL] in Chinese
Vol 18 No 2, Apr 89 pp 63, 12

[Unsigned article: "Regarding the Collection of Papers Called 'Artificial Neural Networks and Their Application in Knowledge Systems"]

[Text] In the fall of 1987, the Chinese Academy of Sciences (CAS) Institute of Automation accepted a research project called "Groundwork in Artificial Intelligence" from the Plan 863 Intelligent-Computer Specialists Group, and on the basis of existing work, they concentrated on studying knowledge of systems. In the view of those involved, two important modes of thought are logical thought and iconic thought (direct perception), and in the past, rule-based knowledge systems have been considered to emulate human logical thought, but there has been little work done on simulating human iconic thought. Proceeding from their network structure models, they explored iconic thought and analyzed some existing artificial neural network models, as for example that of Rumelhart in which is proposed the reverse propagation model. In reality, this is a classifier for monitored learning, as the network input is a group of numeric values (sometimes called "characteristics"), while what is output is categorical distinctions. It is necessary for human intervention if characteristics are to be extracted from expert knowledge or experience and if these characteristics are to be added to their corresponding knowledge. Therefore, not only is this a network function, but it must also be accompanied by human functions. The network is useful for determining weighted values in the network after learning from real examples, which is the stimulus for studying network models, but this is not the same as traditional methods, and the collected papers in this book reflect the application of these networks to knowledge systems and system identification, as well as showing the results of analyzing algorithms.

1. The Reverse Propagation Model

Research facts relating to intelligent systems may be divided into two parts: on the one hand are the mechanisms for studying human thought and behavior, which is theoretical work, primarily evident in psychology and brain studies research; on the other hand, the primary research effort is on how to simulate human thought activities on the computer, as well as to generate various models for intelligent behavior, which is the subject matter when artificial

intelligence is applied to computer science and engineering. Most of the research on network models reflected in this book is concentrated on the latter, but has also recently emphasized applications of the reverse propagation model.

In artificial intelligence research, the reverse propagation model can actually be seen as a mode of expression. The most important characteristic of this expression mode is the distribution of information. Traditional expressions concentrate knowledge in expressions, which is to say that a fact or a rule is manifest and determined within a number of units, and this method has been proven effective over the development of artificial intelligence during the past 30 years. But some human knowledge cannot be effectively expressed using this method. In order to resolve this problem, fuzzy values have been introduced. What has been unfortunate is that although the motivation for introducing fuzzy values is correct, research methods have concentrated on comprehensiveness, not learning, or in other words, fuzzy-set research assumes a situation in which the degree of attachment is already known, but it is just this degree of attachment that is so hard to provide. Another major defect with such methods as these is the fact that the description of every physical value is mapped to a real number. For example, the Bayes rule describes with a priori probability, while fuzzy mathematics describes things by using degree of attachment. Many real examples can be used to demonstrate this defect, as for example, the fact that the concept of "high" is related to what is being said. Therefore, this concept can only effectively be described under particular conditions. This is exactly the strong point of the reverse propagation networks. Through learning algorithms, they can distribute information expressed by characteristics within a network and consequently can not only effectively describe, but can also automatically retrieve the knowledge from these iconic thoughts.

These networks can certainly not replace the logical modes of description. A positive step is to combine the use of networks with other methods, which will effectively bring together such areas as expression, inference, acquisition, and interpretation. Systems engineering has proposed the view that combines various fuzzy knowledge systems, deriving four major models. The paper by Wang Jue [3769 3778] and Dai Ruwei [2071 3067 3634] entitled "One Method for Building Artificial Neural Network Knowledge Systems" describes a method for treating parallel distributed processing networks as elements to be included in general semantic networks, and implements the integration of network models with logical models. The key is in putting forth the concept of network modules as the expression bridge for this kind of knowledge, which ensures that these networks can be joined with other knowledge-expression methods. To this end it presents a method that is completely different from traditional inference demonstration and interpretation methods, namely, interpretation that is based upon real examples. These thoughts are realized in the development tools in the shell PESS of the expert system completed by Wang Jue and others.

2. Applications in Knowledge Systems

It is extremely natural to apply the principles of reverse propagation models to knowledge systems. Here, I will describe two knowledge systems, namely, the nuclear-reactor fault diagnostic expert system developed by Yang Yiping [2799 0001 1627] and the Chinese-medicine medical diagnostic expert system developed by Tian He [3944 4421], which are attempts to combine traditional methods with new thinking.

The nuclear-reactor fault diagnostic expert system is the first knowledge system to be done with the reverse propagation networks. This system includes the two networks: one for electrical-drive fault diagnosis and one for mechanical fault diagnosis. The system uses the PESS definitions, which after learning are built into a system.

The Chinese-medicine diagnostic system was the first used for a pediatric cough and breathing system, which has developed into a specialized package for Chinese-medicine medical diagnosis. This work will set a good example for Chinese-medicine knowledge systems because Chinese medicine is a typical field emphasizing iconic thought and the traditional logical method greatly limits the capacity for acquisition and expression in Chinese medical experience. This system similarly uses the PESS definitions, and at present these two systems can both be demonstrated.

3. Applications in Project Control

The prerequisite for realizing automated control is identification of the controlled object. The traditional method generally uses the linear least squares method, and its range of applications is limited, so can it use network structures to describe a model of the object? In an attempt at a chemical reactor, Xu Yaoling [1776 5069 3781] showed that this is another path for system identification.

4. Analysis of Various Artificial Neural Network Algorithms

The work of Yin Hongfeng [1438 4767 7364] was done on the basis of that just described. He carefully analyzed various artificial neural network algorithms, added his ideas, and provided inspiring opinions and reference materials for the research group. His work with algorithms, and especially his methods for improving the models and quickening learning with associative memory, is fundamentally significant work.

This anthology has collected eight papers, and it reflects the major research results during 1988 for their authors. Some more penetrating topics--as for example a summary of iconic thought to logical thought in knowledge systems, characteristic extraction, clustering analysis, qualitative inference with knowledge as the basis, and in the area of control, self-adaptive development and resolution of multiple-goal control problems--are all on the agenda.

In addition, Liu Yingjian [0491 6601 1696] has achieved some pleasing results regarding use of reverse propagation network theory to undertake recognition

of hand-written fonts, which could not be included in the anthology in consideration of time constraints, surely unfortunate.

Research on expert systems at the present time is in the following state: Many people are building their own expert systems in different fields at the frontiers of research, and there are fewer problems with these systems. The work just described shows the energy with which they are trying to break through the limitations mentioned herein, that is, to pay attention to iconic thought, seek out new opportunities, and take the study of knowledge systems even deeper. Naturally, the task they face is enormous.

Work, Components of CAS Institute of Automation

40080179b Beijing KEJI RIBAO [SCIENCE & TECHNOLOGY DAILY] in Chinese 29 Apr 89 p 3

[Article by Song Zhaohang [1345 0340 5300]: "CAS Institute of Automation Moves Forward During Restructuring"]

[Text] Introduction

The Chinese Academy of Sciences (CAS) Institute of Automation is an integrated new-technology institute that concentrates its research on automatic controls and data processing. The staff of the institute numbers nearly 600, and there are more than 400 scientists and technicians, among whom are included nearly 100 higher-level scientists and technicians and about 200 of the mid-levels. The institute directorship is held concurrently by the CAS deputy director, Hu Qiheng [5170 0796 1854].

The Institute of Automation is a registered member of the China Society of Automation, and it has wide-ranging contacts with relevant scientific research organizations, colleges and universities, and industrial enterprises, both in China and abroad. This institution has also assumed responsibility for training high-level scientific and technical skilled personnel for the state, for which task there are currently three Ph.D. advisors, with some 130 persons at the institute studying for either Ph.D. or Masters degrees. This institution has always been one of the units in China where graduate students have tested highest.

In accordance with the principle that science and technology must serve economic reconstruction, since 1983 the Institute of Automation has worked hard at furthering the integration of science and technology with the economy, and it has been active in exploring the restructuring of such areas as changing the operational mechanisms of the institute, optimizing S&T contingents, furthering the rational circulation of personnel, and motivating the enthusiasm of staff, which efforts have resulted in clear results.

On the one hand, they have maintained the primary struggle to arrange for placing and motivating the majority of S&T efforts into economic reconstruction. Since 1983, they have been tasked with 118 major national key projects, with 68 other projects due to lateral commissions, and they have come up with 109 S&T achievements, the majority of which have been disseminated and applied, and 32 of which have won S&T achievement prizes at the academy or provincial ministry level. Examples of these include the dissection and analysis of large-scale integrated circuits, the application of synthetic ammonia collection and dispersal computer systems, and international-software-standard graphics general-purpose editing systems and video radar simulation systems, all of which have brought clear social and economic results. At the same time, the institute has actively arranged for the development of high-technology products, and has already put into production such things as a high-resolution graphics workstation, a graphics processing system, an infrared thermometric instrument, a raster digital display, a high-precision broad speed-control system, a radar training simulator, a constant-force support lever, and a microcomputer power supply. Among these, the image processing system CA-series image acquisition card has been evaluated as a key high-technology product in the [Beijing] New-Technology Development Region for 1988. The China Automation Technology Company, founded with funds from the Institute of Automation, has grown rapidly in recent years, and gross sales for the company grew from the 1.5 million yuan in the startup year 1985 to 100 million yuan in 1988. This makes it one of the most powerful high-technology enterprises of CAS in the Beijing Municipality New Technology Development District. The volume of annual self-supplied funds for the institute has also continued to grow, as the self-supplied funds for 1988 have now surpassed the level of allocated funding for the institute before restructuring.

On the other hand, as the institute is energetically strengthening its technology development, it maintains a talented contingent engaged in the application of basic research and high-technology tracking, and in such fields as control theory, systems theory, reliability theory, pattern recognition, artificial intelligence, and robot vision, it is maintaining a high standard of research. Since 1983, the institute has taken on 35 projects of the state and CAS natural sciences funds, and researchers have presented or published more than 350 papers at academic conferences and in journals both in China and abroad. Many research achievements have drawn respect and praise from scholars both here and abroad. Among these are: schema description and representation methods, control systems reliability analysis and integration, Beijing-Tianjin regional ecological and economic districting, encouragement policies, and applications of these things. The Pattern Recognition Major National Laboratory, built by this institute with funding by the state, was completed in 1987 and was opened to people in China and abroad. It has become an important base for China as it develops high-level research and trains skilled personnel in the field of information sciences.

Restructuring has enabled this institute to shine with new vitality, and there has now been formed a preliminary benign cycle whereby science and technology are joining with the economy, development efforts in applications and basic research are spurring each other on, and the young S&T skilled personnel are continually maturing. The restructuring has also posed new goals for the growth of this institute, and it is currently engaged in the effort to bring Chinese control and information technology up to advanced world standards, which will give us the strength to form and develop China's export-oriented high-technology enterprises.

Vital New Force

Adoption and implementation of the guiding principle, "science and technology must serve the economy," that has such deep significance for the restructuring of the science and technology system, will enable great changes in S&T efforts at the CAS Institute of Automation. The institute is currently putting more than 80 percent of its strength into serving the main battle for national economic reconstruction; it is actively accepting research and development tasking from the state, regions, and from industry, and it has made significant gains therein.

In recent years, the Institute of Automation has actively sought and assumed 36 projects as issued by the state under S&T projects of the Seventh 5-Year Plan, the "863" high-technology [plan], and CAS scientific research and military industrial projects, which account for 43 percent of the annual all-institute project starts. More than 50 percent of the institute personnel are involved in this work, and it receives more than 8 million yuan in funding through them. With its own dominant technology position, the Institute of Automation is doing developmental research in such fields as computer graphics, image processing, electromechanics, and production process control, as well as in pattern recognition, intelligent computers, intelligent robots, and speech and signal processing technologies. From this work, their dozens of such high-level accomplishments include intelligent dissection and analysis systems for integrated circuits (IC's), Computer-Aided Design (CAD) graphics processing systems, Beijing-Tianjin-region ecological and economic districting, and pillar-burst data processing systems, which have prospects for broad applications in aspects of the national economy and national defense efforts. Among these accomplishments, the IC dissection and analysis system comprehensively adopts the methods and techniques of artificial intelligence and pattern recognition to use a computer to automatically analyze the microimage of the layout of an IC chip. This rapidly and accurately obtains data about the layout of the chip's integrated circuitry. The functions of this system are basically the same as those of similar systems abroad that are publicly available, and the system may be used for the analysis and design of large-scale integrated circuitry (LSI), which makes it very useful for learning from foreign techniques as we develop new products with Chinese-produced integrated circuitry.

To as quickly as possible realize the technological transformation of China's traditional industry and the upgrading and renewal of our export products, the Institute of Automation has established lateral cooperative relations with dozens of industrial enterprises from more than ten provinces and municipalities, from whom they are accepting commissioned tasking. The institute has come up with many effective, high-level achievements in the aspect of automation for such industries as steel, petroleum, chemical engineering, concrete, and tobacco, which have brought outstanding economic results to the commissioning units. In 1988, the Institute of automation completed its task of transforming the technology of the batch workshop of the Polyester Fiber Plant of the Tianjin Petrochemical Company. The scientists and technical personnel in charge of this work paid no heed to discomfort and inconvenience as they worked incessantly to ensure the early completion of this task. The project will result in gains of tens of thousands of yuan in tax benefits for the plant, for which the plant has been grateful. The cement-plant unprocessed-goods-assembly computer control system developed for the Pingxiang Cement Plant in Jiangxi has also been successful in the higher technology specifications, by which they have brought about a great rise in the quality of finished cement products. Other successes have gone into production, as for example a chemical-fertilizer production control system for the proportions of hydrogen and nitrogen, and synthetic-ammonia production control system, all of which have made contributions to the technological transformation and "dual increases, dual phases" of the manufacturing enterprises.

By accepting various tasking from the state, from industrial enterprises, and from the military sector, annual accumulation of funds by the institute is more than half the total income for its self-generated funding. This will undoubtedly play an active role in seeking the progressive self-generation of funds for scientific research and in ensuring progress for each task.

By making the most of its technological advantages, the Institute of Automation is actively developing advanced, practical, and marketable products, and in a planned way they are disseminating to such industries as petroleum, chemical engineering, and cement, advanced and special technologies and likes of industrial control systems, management information systems (including the integration of control processes and network technology), electromechanical energy conservation control systems, and solids storage and management, which will in time produce even greater contributions to national economic reconstruction.

National Pattern Recognition Lab

The State Pattern Recognition Open Laboratory is a national primary laboratory built by the Institute of Automation. With state approval, the lab officially opened to others, both foreign and domestic, at the end of 1987. The laboratory is furnished with equipment of an advanced international standard of the 1980s and includes four divisions: public

systems, phonetic systems, microimage processing systems, and artificial intelligence systems. There are nearly 30 permanent research personnel and a high-quality, highly capable technical staff for management and maintenance. The laboratory can annually financially assist 30 guest research personnel to do research at the lab.

The lab is primarily engaged in applied and basic theoretical research in pattern recognition and high-technology developmental research. primary directions of research include computer vision, speech recognition and natural language understanding, artificial intelligence and intelligent robots, and computer graphics.

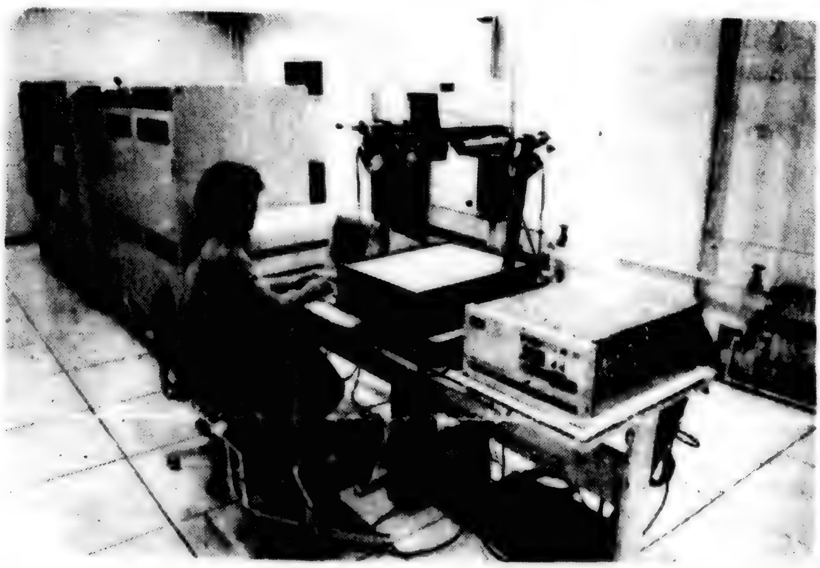
Open to others for more than a year now, whether in basic theoretical research or high-technology developmental research, the laboratory has come up with many achievements. In the area of basic theoretical research, researchers have published more than 50 papers, among which more than half have been presented at major international academic conferences or published in major international academic journals. For example, at the Ninth International Conference on Pattern Recognition, one paper there presented concerned a Huff transform that is being disseminated as enabling the complexity of traditional algorithms used in shape recognition to be reduced from $O(m^4)$ to $O(m^2)$; a paper presented at the 1988 IEEE annual computer science conference proposed a new shape description method--the shape tree method; and a paper presented at CADMAT88 proposed a new neural-network computer model for use in image high-level matching.

The lab has also achieved much in the area of high-technology developmental research. For example, they have successfully developed and put into operation a laser-ranging data instrument for use in the measurement of three-dimensional solids and visual information acquisition that is of an advanced international level; they have developed the first domestic computer simulation system for use in systolic parallel-processing system structures; and in the area of neural-network image code compression, they have realized a color single image with a compression ratio of 45:1, which meets advanced international standards. In the area of speech recognition, they are currently in developmental research for transforming into a commercial product a deaf-and-dumb phonetic teaching system that has won a CAS second prize for S&T achievement. The successful development of this system has been warmly received by many disabled persons both in China and abroad, and it has major social results.

The laboratory has implemented the principles of openness, alliance, and mobility. Among permanent and guest researchers working here, there are both middle-aged intellectuals of great scholastic achievement, and also young scholars who are intellectually active and accomplished in their professions; and there are both Ph.D. and Masters graduates trained in China, and also Ph.D. students who were educated abroad. They are seldom conservative in their thinking, and at each weekly scholastic

meeting they each put forth their views; discussion is quite lively, which creates a deep scholastic atmosphere and fosters a research environment that is unifying and cooperative.

Many of the guest researchers have made important research achievements in a relatively short time. Scholars of international reputation from the U.S., France, and Japan have produced many valuable achievements over wide areas, which provides full affirmation and praise for the institute.



A View of the Pattern Recognition Laboratory

Basic Research

After the institute shifts the focus of its efforts from applications research to developmental work, is it also to put energy into basic research? The leadership of the Institute of Automation and the scientific and technical personnel engaged in basic research have made a clear response by their actions. Since 1988, the institute has retained a skilled high-quality basic research force; they have drawn up clear applied and basic research projects that have an eye toward applications, most notably applied and research projects in high technology; and they have set up funds for basic research to improve the degree of funding for basic research. To enable the younger scientists and technicians to produce achievements early, the institute is providing support for the basic research projects with new thinking, new viewpoints, and new trends that have emerged from the younger research personnel. Since 1983, important achievements have been made in such areas and applications as semantic and syntactic pattern recognition, the ecological and economic districting of Beijing and Tianjin, policies

of encouragement, and gradient algebra. Young institute scientific and technical personnel who are members of the CAS group for analysis and research of the national condition have used systems and control theory to do in-depth quantitative analyses of the primary factor influencing the long-term development of China's countryside--the population problem. They have also set up a China population-economic system model, an integrated model for land resources and bearing capacity, and a food-production forecasting model, all of which do forecasting of fundamental relations between the rural population and subsistence growth, as well as forecasting of developmental trends. They have then used this work to propose basic strategies and primary policies by which to sustain growth, and this work has bene appreciated by the relevant leadership and decision-making departments of the central authorities.

Institute of Automation researchers engaged in intelligent-technologies research recently established the first domestic hand-written Chinese character sample base containing 1,000 samples totaling 4 million characters. This sample base will provide the basic material for the study of the development of recognition techniques for hand-written Chinese characters. Neural networks are an important direction for contemporary data-processing research, and after some intensive research, researchers at this institute have proposed new methods for integrating logical psychological models, artificial neural netowrk models, determinative physical models, and cognitive knowledge models, that provide new ways to develop expert systems. This method has had an effective trial in such fields as nuclear-reactor-incident diagnostic expert system and system identification, which has laid an excellent foundation for the application of neural networks in knowledge systems. In addition, in aspects of the design of intelligent computers and multiple-model expert systems, they have also done work with outstanding results.

The researchers at this institute have also come up with a number of high-level achievements in the areas of complex-system theory and control, control-systems reliability analysis and integration, encouraging policy making in multiple-source decision-making theory, and discrete-event dynamic systems, and some have been applied in actual practice. For example, the encouraging decision-making methods have been used for water, oil, and gas conservation in factories, where they have generated significant economic and social results.

With the guidance of the CPC Central Committee's principles of restructuring and openness, at the same time as the Institute of Automation has been strengthening its relations with all economic sectors within China, it has been establishing definite and cooperative relations with research and academic organizations in the U.S., West Germany, England, and France through such means as bilateral academic exchanges, mutual visits, and cooperative research, all of which has powerfully advanced the development of basic research. In 1988,

researchers at this institute wrote more than 100 papers, one-third of which have either been presented at international conferences or published abroad.

The intensifying basic theoretical research is providing the background for the development of applied technology and products, and the projects in basic theory that have been proposed during development efforts are in turn stimulating basic theoretical research. The situation at the Institute of Automation is now one in which basic and developmental research complement each other.

Production Company

The China Automation Technology Company (CATC) was founded by the CAS Institute of Automation in 1985 in accordance with the principle of science and technology serving efforts at building the national economy and to advance the transformation of scientific research achievements into productivity. After a 4-year struggle, it has become an S&T enterprise with considerable technological depth, one that sits securely on "Electronics Street" and that has been judged to be one of the ten largest enterprises in that area, as well as being "very financially trustworthy" by the financial community. In 1988, CATC was rated as sixth among the "honor roll or computer sales and service enterprises" from within the machine-building and electronics industrial system throughout the country.

CATC is backed up by the technological strength of the Institute of Automation, and it concentrates its efforts on the development of high-technology products. The company's Image Products Development Division has developed the CA-series of image acquisition cards in accordance with market demand, and the future for this device is quite broad, as it is suitable for many different industries. This product is now in applications at many industries in over 20 provinces and municipalities throughout China, and its level of quality is the equivalent of similar foreign products. In cost-performance ratio, it is capable of competing with imported products. Annual sales volume for this product has reached into the millions of yuan, and in 1988 it was judged to be the hot item in the Beijing Municipality New-Technology-Development Experimental District.

With the development of computer technology, CAD/CAE/CAM systems are rapidly becoming ideal modern tools for departments involved with industry, research, education, and international affairs. To meet the demands of the domestic market and to conserve foreign exchange for the state, CATC used existing technology of the Institute of Automation to quickly develop a computer imaging system and also to put it promptly into the marketplace, where it has been welcomed by customers. More than 110 of these systems were sold during 1988, for a total sales volume of 3 million yuan. According to evaluation by experts, this system has attained the level of similar foreign products. Currently,

the computer imaging system is being used by more than 100 firms within China; it has been quite effective, has produced excellent social and economic results, and has been awarded a second prize for advanced S&T achievements by CAS.

In addition, CATC has also developed more than 20 electromechanical products such as an electromechanical speed-control system, CAM 386 microcomputer, small numerically controlled drilling machine, raster digital display, and closed-circuit television system with related components. Over the past 4 years, CATC has relied upon the technological strength of the Institute of Automation and guidance by the marketplace to make firm progress. And it has achieved a distinct scale in such areas as product development, manufacturing and sales, and after-sales service.

By the end of 1988, CATC has accumulated about 15 million yuan in self-generated funds, as well as generating an enterprise scale of more than 100 million yuan in annual volume of operations.

CATC is now actively developing both foreign and domestic markets, and not long from now, CATC products will enter the international marketplace.

3-D Graphics Systems Pass Evaluations

40080180a Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 17, 3 May 89 p 1

[Article by [surname only] Mu [2606]: "Application Begins for Domestically Developed '3-Dimensional-Element Modeling System' and '2-,3-Dimensional Graphics Interactive Processing System'"]

[Text] The "3-Dimensional-Element Modeling System--GEMS 2.0" and the "2-, 3-Dimensional Graphics Interactive Processing System--GIS 2.0" independently developed by the Qinghua University Computer Science and Technology Department as a key S&T project of the state's Seventh 5-Year Plan passed their technical evaluation in Beijing on 18 April.

GEMS 2.0 is a 3-dimensional-element modeling system that can run on 32-bit supermicrocomputer workstation systems (such as the Apollo DN3000); its many functions include such as definition of shapes, set operations, transform output, true color graphics display, object calculations, and collision detection. GIS 2.0 is a 2-,3-dimensional utility interactive graphics system developed also on the Apollo DN3000 workstation. It is based upon input and output of points, straight lines, circular arcs, free curves, and characters, and has as its primary user interface screen menus that are dynamically layered. By defining different coordinate spaces, work surfaces, windows and views, one can handle symbols, graphics groups, levels and document files, together with such operations as the input of graphics elements and structures, display, deletion, editing, geometric transforms, standard notation, measurement, and setting attributes. These constitute the functions of interactive graphics input/output and of graphical plotting for computer-aided design.

The evaluation experts felt that with these two systems the defining of shapes is convenient and easily understood, and that the many types of transform output are fast and highly reliable. The systems employ the layered-screen-menu user interface that is so popular abroad and that is convenient to use. These two systems are both critical pieces of software for CAD/CAM and meet advanced international standards for the eighties, and they are special in their novel conception, advanced algorithms, and innovations as evidenced by such functions for shapes as angular sectioning of arbitrary positions and intra-object dynamic progressive viewing. These two systems not only may be

used directly for engineering and product CAD/CAM in such professions as machinery, electronics, civil construction, and chemical engineering, but can also be used in such applications systems as emulation and simulation, animation, and computer vision.

At present, it would cost at least US$30,000 to equip a CAD workstation with a set of executable programs in similar software from abroad. During the Eighth 5-Year Plan, thousands of major enterprises in China will need to use CAD/CAM technology. By using domestically developed systems, not only can we conserve large amounts of foreign exchange, we will also prepare the way for similar high-technology products having intellectual property rights to enter international markets.

Also passing technical evaluation was the "System for Analyzing the Assimilating D3M Database Management Systems." The [development of this] system was also a key S&T project of the Seventh 5-Year Plan. This product is the first domestically to accomplish the analysis, assimilation, and exploration of D3M database management systems, and it has successfully applied D3M database management systems in aspects of CAD data management. It will play an active role in promoting the application and development of China's CAD/CAM technology.

New Dispatch, Command Workstations Exhibited in Beijing

40080180b Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 17, 3 May 89 p 1

[Article by [surname only] Hai [3189]: "New High-Grade Dispatch and Command Equipment"]

[Text] The Sanle [0005 2867] Electronic Technology Development Unit in the Haidian District of Beijing recently publicly exhibited the 86T-1 Attended Workstation, high-grade dispatch and command equipment that integrates the circuitry for three functions: telephone communications, data terminal (Chinese character), and graphics (video) monitor. The first group of experts to view this equipment praised it as having many functions and being very useful, and they said that its dissemination and application are sure to bring China's control capability for dispatch and command systems to a new level.

This operator's station is an upgraded product of existing domestic operator's equipment, and with its successful development by an institute of the [PLA] General Staff and the Sanle Electronics Technology Development Unit after several years of hard work, it has now gone into small-batch production.

The workstation uses advanced microprocessor [stored program controlled [SPC]] technology, and has such functions as call placing, call retention, call encryption, call forwarding, facsimile, call recording, and call time logging, and it can also connect with computer network systems for the transmission and video display of text, data, and graphics. The whole workstation comprises three parts: telephone operator's station, data (Chinese character) terminal, and graphics monitor. Each portion is assembled from modules, and each can either be set up and used alone, or can be organically integrated into a system by combining any number of branch units according to the user's needs.

Exhibited together with the new operator's workstation was also a new microcomputer input picture transfer converter. This high-resolution video interface equipment can convert video signals input from computers of several different resolutions into visible signals of the same scanning frequency, which can then be displayed in turn on the same monitor or by large-screen projector. It is therefore useful in dispatch, command, and decision-making systems, and for electronic conferencing.

Changjiang Introduces Four New Microcomputers

40080180c Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 17, 3 May 89 p 1

[Article by [surname only] Kui [6652]: "The Changjiang Computer (Group) Joint Company Promotes Four New Microcomputers"]

[Text] At its second anniversary celebration on 12 April, the Changjiang Computer (Group) Joint Company formally announced four new microcomputer models: the Donghai 0520DH, the Donghai 0530EX, the Donghai 0540A-16, and the 0540-25, and also announced their wholesale and retail prices.

Donghai 0520DH microcomputer. This was developed on the basis of the Donghai 0520C and 0520D computers. The CPU is the Intel 8088 with a master [clock] speed range of 4.77-10 MHz and a 10-MHz 8087 co-processor. Basic configuration: one 20-megabyte hard disk drive and two 360K/1.2-megabyte floppy disk drives, with an optional 60-megabyte dataflow cartridge tape drive, choice of either monochrome or color display, enhanced 101-key keyboard, eight I/O slots, two serial-parallel interfaces, and abundant general-purpose applications software, all of which makes it suitable for the special requirements of banking and management.

Donghai 0530EX microcomputer. This machine was developed from the Donghai 0530B and 0530E computers, and is completely compatible with the Donghai 0530B and AT-class 286 microcomputers. The CPU is an Intel 80286 with a master [clock] speed range of 8-12 MHz, and a maximum speed of 16 MHz. The operating speed of this machine is the fastest among current domestic 286-class computers, and the external storage system has been improved, as it can support two 1.2-MB floppy disk drives and two 20- or 40-MB hard disk drives. Options include a 60-megabyte dataflow cartridge tape drive (which can be mounted internally), a 14-inch high-resolution color display, and an enhanced 101-key keyboard. There is a system-reset button on the face of the computer and a button to change the operating speed, and when the system locks up, it need not be turned off before restarting. There is much software, which is compatible with that of other models.

Donghai 0540A microcomputer. This is a newly developed 32-bit high-quality microcomputer following upon the Donghai 0520 and 0530 computers. The CPU is an Intel 80386, the co-processor is an 80387, and the master [clock] speed

range is 16-25 MHz. The system is built from multi-layer printed-circuit boards, gate arrays, and high-capacity external storage equipment, and it has a 16-level interrupt and 7 communications channels; it may be fitted with two 1.2-megabyte floppy disk drives, two hard disk drives of 20-130 megabyte capacity, a high-resolution color monitor, a high-speed printer, an enhanced 101-key keyboard, and a speaker port. There is a great deal of Chinese-Western language software, it is completely compatible with existing PC/XT and PC/AT applications software, and the high-level languages running presently on domestic PC-class machines will all run as desired on the Donghai 0540A. This computer is one of the fastest, most powerful and most reliable among the many 32-bit high-performance microcomputers currently available at home or abroad. It is suitable for CAD/CAE, as well as for the needs of such fields as publishing, banking, finance and taxes, office automation, and automatic control of production processes.

Jiannan Machinery Plant Develops 23 High-Tech Export Products

40100063 Beijing XINHUA in English 0116 GMT 30 Jul 89

[See also JPRS-CST-89-014, 18 Jul 89, pp 48-49]

[Text] Beijing, July 30 (XINHUA)--Since 1984, the state-owned Jiannan Machinery Plant, under the Ministry of Machine-Building & Electronics Industry, has developed 23 high-tech products for export. Its exports of magnetic heads and slide pads rank first in the world, CHINA DAILY reports today. The plant is the country's largest enterprise that mainly produces peripheral equipment for computers.

Located in the mountains of western Hunan Province, the plant sometimes lacks market information. To overcome the disadvantage, the plant established a branch in the coastal Shekou special economic zone as a window on the world market. It has also invited foreign experts to help improve its technology. In the last 4 years, some 100 engineers and technicians from Hong Kong and the United States have come to the factory to train its workers. With the help of overseas cooperation, the factory has exported more than 10 varieties of high-tech products. Cooperating with technicians from the United States, the factory has mass-produced 5.25-inch floppy disk drives. More than 30 million yuan worth of these disk drives have been turned out by the factory.

The factory arranges its production according to market demand. When the Beijing Great Wall Computer Development Company needed disk control adapters to fit newly developed computers, the factory studied the product and succeeded in providing the adapters within a year.

Experimental Investigation of Immediate Bandwidth of Meteorological Satellite Imagery

40080113e Beijing TONGXIN XUEBAO [JOURNAL OF CHINA INSTITUTE OF COMMUNICATIONS] in Chinese Vol 9 No 6, Nov 88 pp 92-94

[Article by Xu Jianping* [1776 1696 1627] and Liu Zhiping** [0491 2535 1627]: "Experimental Investigation of Immediate Bandwidth of Meteorological Satellite Images"; manuscript received 2 Jan 86]

[Text] Abstract

This is an experimental analysis of the immediate frequency spectrum of meteorological satellite images in order to verify the effect of filter bandwidth. It was found that the bandwidth could be compressed by approximately 50 percent without affecting the quality of meteorological satellite images.

I. Introduction

When a meteorological satellite image is received or transmitted, the bandwidth of the receiver or transmitter is determined by the signal modulation method and the frequency band of the baseband image signal. With a fixed signal modulation method, therefore, bandwidth depends on the frequency band of the baseband image signal. The baseband image-signal frequency band is calculated based on a black and white image. For example, the third-generation U.S. meteorological satellite

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TIROS-N/NOAA has six scan lines per second and each scan line has 2048 pixels. The maximum frequency band is (2048/2)x6 $\approx$ 6 kHz, which occurs when every other pixel is black and white. However, neighboring pixels in a meteorological satellite image are correlated, especially when there are clouds. This means that there is some information redundancy and the bandwidth is less than 6 kHz. Thus, the question is how wide the bandwidth of the meteorological image should be. Is it possible to compress the bandwidth of the image? If so, by how much? Since the image varies widely and the quality requirement differs, it is not easy to resolve this issue based on theory. Therefore, this paper attempts to explore this problem experimentally.

II. Immediate Frequency-Band Analysis

There are two common methods to measure the frequency spectrum of a signal. One is to measure point by point. A narrow-band filter is used to determine the power within the bandwidth of the filter. By varying the center frequency of the filter, the signal power levels at different frequency ranges can be determined. The other way is to display the signal frequency spectrum with a scanning frequency spectrometer. Either method provides a mean time integral value of power within a frequency range. It is an average frequency, rather than an immediate frequency spectrum. If the signal is cyclic and the frequency spectrum is time-independent, such measurement is accurate. If the signal is random and the frequency spectrum continues to vary, then the integral signal power over a specific time period cannot represent the immediate frequency spectrum at that instance. Instead, it is an average over the time period.

Satellite images are random signals. The bandwidth of some immediate frequency spectra may be much wider than that of the time-averaged frequency spectrum. If the bandwidth given to the transmitter is the same as that of the average image frequency spectrum, the edges of the transmitted imagery are blurred. Hence, it is better to measure the immediate frequency spectrum, i.e. to record the image signal at an instance, for further analysis. The Model 2033 frequency spectrometer made by the Danish firm BK Company has such functionality. It can record the signal at a specific instance for spectral analysis. The experimental method used in this work is shown in Figure 1. During a satellite pass, the receiver gets the signal transmitted by the satellite and the Model 2033 frequency spectrometer captures and stores the immediate signal for analysis. Of course, the signal received by the receiver can be recorded on tape and re-played later; [at that later time one could then] perform immediate frequency spectrum analysis on the Model 2033 spectrometer. Figure 2 shows the typical immediate frequency spectrum thus obtained.

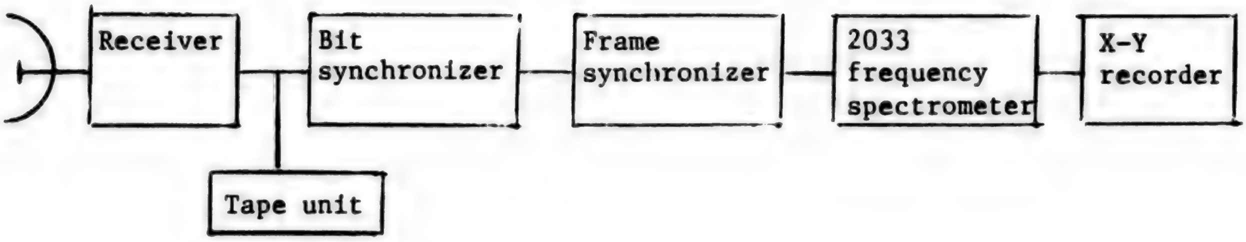

Figure 1. Immediate Frequency Spectrum Measurement Technique

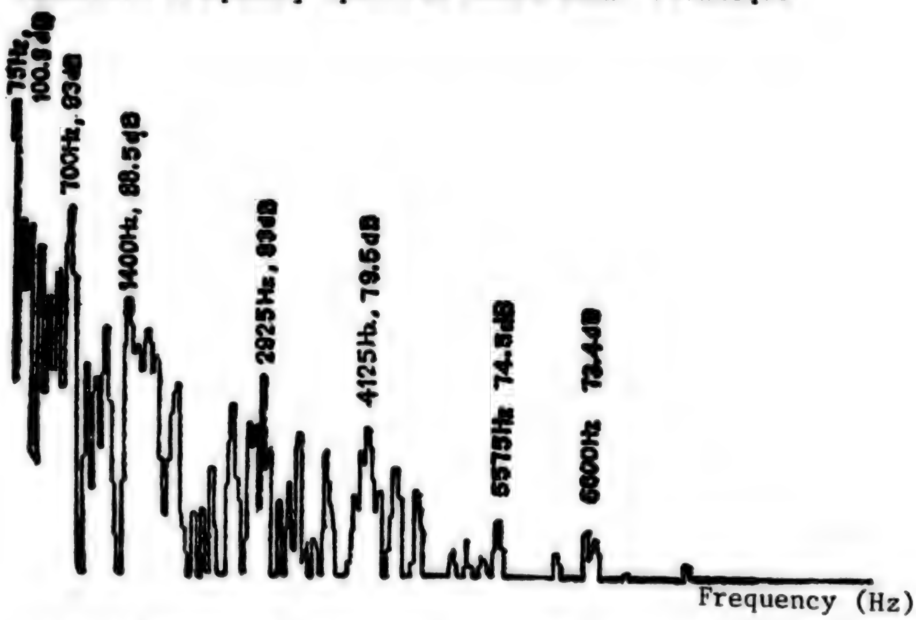

Figure 2. Typical Immediate Frequency Spectrum from the NOAA-7 Meteorological Satellite

III. Results of Analysis

We conducted 62 frequency analyses on images transmitted from the same orbit at different times, from different orbits and different detection channels (the TIROS-N/NOAA satellite has five detection channels). The bandwidth was chosen to be 10 dB below the immediate frequency spectrum power and the results of the 62 measurements are as follows:

Bandwidth (kHz)	0.1	0.12	0.14	0.15	0.16	0.2	0.22	0.26	0.3	0.4	0.5	0.55	0.6	0.7	0.9	1.0	1.3	1.5	1.8	2.0	3.5
Occurrence	13	3	1	3	1	7	1	1	4	5	4	1	1	3	1	6	1	2	1	2	1
Cumulative Probability Distribution	0.21	0.26	0.27	0.32	0.34	0.45	0.47	0.48	0.55	0.63	0.69	0.70	0.725	0.77	0.79	0.89	0.90	0.94	0.95	0.98	1

We know that 98 percent of the image is within a 2-kHz bandwidth and it can be compressed by approximately one half.

In order to verify this conclusion, we passed the image signal through filters of different bandwidths to generate images on a facsimile machine to observe the effect of bandwidth on image. As shown in Figure 3, the image is first stored in a computer. The bandwidth of the filter is changed and the image is then retrieved from the disk to be generated on a facsimile machine to obtain a series of images.

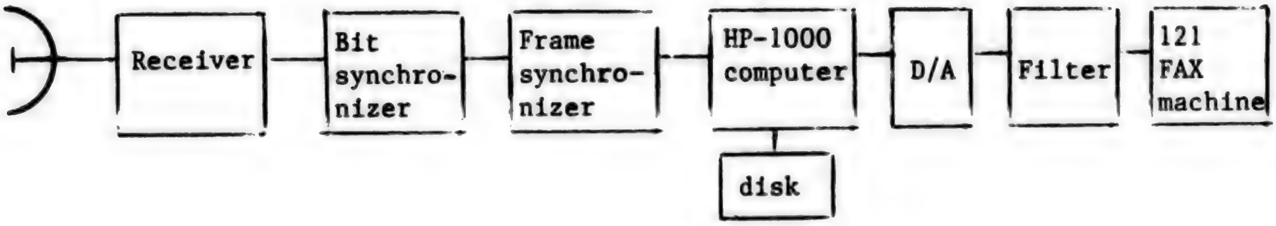

Figure 3. Effect of Filter Bandwidth on Image

Figures 4 and 5 [photographs not reproduced] show the original meteorological satellite typhoon cloud picture and the original geomorphological image with infinite filter bandwidth, respectively.

A series of images was obtained when the filter bandwidth was 6 kHz, 3 kHz, 1.5 kHz, 0.75 kHz and 0.3 kHz. They were studied by experts who are familiar with reading such images. When the bandwidth is 6 kHz, the typhoon cloud pattern is identical to the original photograph. The 3 kHz bandwidth image is still very close to the original image. The cloud structure near the eye of the typhoon remains very clear. At 1.5 kHz, the eye is still very crisp, but the cloud wall and some individual fine structures are somewhat blurred; the picture is still useful. At 750 and 300 Hz, although the profile and eye of the typhoon can still be recognized, the cirrus structure, border, coastline and coordinates are blurred. They are no longer usable. With respect to land forms, when the bandwidth is 6 kHz, the meteorological image is

identical to the original. Other than some individual details (such as mountains), the 3 kHz image is very close to the original. At 1.5 kHz, some details such as mountain ranges are blurred.

At 750 and 300 Hz, all details are so seriously blurred that they are no longer usable.

Based on our results we conclude that meteorological satellite images are still usable when the frequency bandwidth is compressed by one half. The criterion is based on visual observation, rather than computer data processing.

IV. Practical Significance of Bandwidth Compression for Cloud Pattern

1. After receiving the cloud pattern, a reception station must send it to its users. It costs less if the transmission channel uses a narrower bandwidth.

2. The diameter of the antenna for reception can be smaller if the bandwidth is compressed. This makes it possible for a ship in the ocean to use a small antenna to receive cloud patterns. For example, the low-resolution facsimile (LR-FAX) cloud map taken by the Japanese geostationary weather satellite GMS requires a standard 2.5-meter-diameter dish in a standard ground station. The pre-amplifier noise index is 3.4 dB. If we use a 1.2-1.5-meter antenna for reception on a ship, it is difficult to meet the carrier-to-noise ratio by reducing the pre-amplifier noise index to 1.5 dB. This requirement can be met by compressing the bandwidth by a factor of 2-3. The cloud image received on the ship is only suited for visual observation.

V. Conclusions

This paper experimentally analyzed the immediate frequency spectrum of meteorological satellite images and verified the results by studying the effect of filter bandwidth on the image. It was found that the bandwidth of the meteorological satellite image may be compressed by approximately one half without any effect on visual observation.

Two-Beam Coupling in Infrared Photorefractive GaAs Crystals

40090069 Shanghai HONGWAI YANJIU [CHINESE JOURNAL OF INFRARED RESEARCH] in Chinese Series A, Vol 7 No 5-6, Dec 88 (manuscript received 11 Jul 88) pp 441-444

[Article by Wang Weili [3769 1218 4409], He Xuehua, Dai Changhong, and Zhang Heyi of the Department of Physics, Beijing University]

[Abstract] Experimental research on two-beam coupling of two counter-propagating laser beams (included angle θ=165°) in a photorefractive Cr-doped GaAs crystal (sample thickness d=5mm, resistivity $\rho=2.2 \times 10^8 \Omega\cdot$cm, mobility μ=4830cm^2/V·s, and absorption coefficient α=1.47cm^{-1}) using a 1.15-micron infrared He-Ne laser is reported. Results are as follows:
(1) For total light intensity I_0 (sum of pumped beam intensity $I_b(0)$ and signal beam intensity $I_a(0)$) = 0.56W/cm^2 and intensity ratio $\beta_0(=I_a(0)/I_b(0))$ = 0.1, the gain coefficient Γ was found to be 0.13cm^{-1} and the diffraction efficiency η was found to be 2.9×10^{-3}.
(2) For I_0=0.10W/cm^2 and β_0=1, the optimal value of η was found to be 8.5×10^{-3}.
(3) When β_0=0.1, for minimum total light intensity I_0=20mW/cm^2, Γ was found to be 0.05cm^{-1} and η to be 0.3×10^{-3}.
(4) In a cubic GaAs crystal, two S-polarized incident light beams, after coupling, will generate P-polarized diffracted light.

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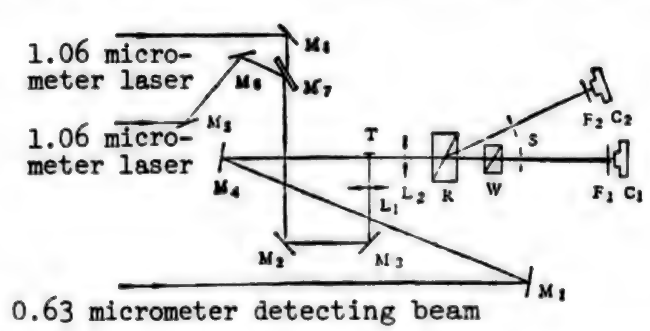
Study of Inhomogeneity Structure in Laser-Produced Plasma

40090060 Beijing ZHONGGUO KEXUE [SCIENTIA SINICA] in Chinese No 3, 89
pp 313-318

[Article by Jiang Zhiming [3068 1807 2494], Meng Shaoxian [1322 4801 6343], Zhang Weiqing [1728 0251 3237], Lin Lihuang [2651 4409 3552], and Chen Shisheng [7115 2514 0524] of Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences; and Xu Zhizhan [1776 5267 1455] of Coagulation State and Radiation Physics Branch Center, China Center of High Science and Technology (World Laboratory)]

[Abstract] The visible light probe imaging method is used to study inhomogeneities appearing in laser produced plasma, especially small scale jet stream structures appearing at the rear surface of a thin film target due to instability in fluid mechanics.

The optical path layout in the experiment is shown in the following diagram.



(C_1, C_2--cameras, F_1, F_2--interference filter plate; L_1--target hitting lens; L_2--imaging lens; M_1 to M_8--special reflecting lens; P--deviation detecting device; R--Rochon lens; S--diaphragm; T--target; W--Wollaston lens)

Four more figures show a plasma interferogram and a schlieren photograph shot simultaneously, magnesium and gold target plasma schlieren photograph, a schlieren photograph obtained when laser irradiation was incident on an 8 micrometer thick gold plane target, and a time developed schlieren photograph of an aluminum foil target plasma.

The authors are grateful to Bi Wuji [3968 2477 1803] and He Xingfa [0149 5281 3127] for assistance with the target range; gratitude is also expressed to the entire crew of the six-channel neodymium glass laser apparatus for their enthusiastic support of this research.

The first draft of the paper was received on 14 April 1987; the final, revised draft was received for publication on 25 May 1988.

New Design Method for Uniform Multimode Lasers

40090056a Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 16 No 5, 20 May 89 pp 260-262, 271

[Article by Li Yongping [2621 3057 1627] and Wu Hongxing [0702 7703 5281] of Department of Physics, China University of Science and Technology, Hefei]

[Abstract] The dimensionless, two-dimensional fast Fourier transform involves using the phase component to calibrate double-mode laser-wave surfaces into a rectangular wave surface computer design. The status of transverse multimode lasers is discussed. The paper presents the results of the TEM_{10} mode. It is easy to surmise that all TEM_{10} should be identical. As for higher modes over TEM_{11}, these can be propagated because the double-mode status was verified, and the two-dimensional transform was adopted; however, the computational volume will be greater. It can be assumed that the multicomponent combination technique can be adopted to use the transform mode in which the higher modes are lowered one by one in order; thus, the adapatability is more. Of course, the conversion ratio will be lowered because of absorption by laser materials.

Four figures show an ideal double-mode intensity distribution, the double-mode intensity distribution after 10 self-consistencies, the homogeneity distribution of the double-mode field after 10 self-consistencies, and the x-direction phase distribution after one self consistency. In the theoretical sense, so-called self consistency is a situation in which the waveforms of the original function (input) and image function (output) after repeated transforms are the same as the original assumption without forced substitution. This self consistency process is an effective measure of substituting diffraction integration.

This study was funded by the State Natural Science Foundation. The paper was received for publication on 22 November 1987.

Two Pulse TE-Mode Photon Echo in Hollow Slab Optical Waveguides

40090056b Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 16 No 5, 20 May 89 pp 280-284

[Article by Li Guangfu [2698 1684 4395] and Zhang Xiufang [1728 4423 5364] of Zhengzhou College of Antiaircraft Artillery]

[Abstract] The paper discusses the two pulse TE mode photon echo problem (including two situations of single- and multivalue modes) of hollow slab optical waveguides. As shown by the results, many different properties are brought to light by comparing photon echoes of hollow slab optical waveguides and for the nonwaveguide situation.

Two figures show a hollow slab optical waveguide, and a two-pulse array for producing two-pulse photon echoes.

The paper was received for publication on 14 September 1987.

Design and Performance of a Colliding Pulse Mode-Locked Nd:YAG Laser Using an Unstable Resonator With Antiresonant Ring Structure

40090056c Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 16 No 5, 20 May 89 pp 302-304

[Article by Sun Zhan'ao [1327 0594 5837], Yang Xiangchun [2799 7449 2504] and Zhu Xiaolei [2612 1420 4320] of Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences]

[Abstract] The article reports on the design of a new convex-antiresonant ring unstable resonator structure; the structure is applied to a colliding pulse mode-locked Nd:YAG laser, yielding satisfactory results with the narrow pulse advantage of the concave-antiresonant ring stable cavity, and high energy advantage of virtual confocal unstable pulses. The pulse width is reduced to the neighborhood of 10 picoseconds; the total energy of pulse train is as high as 69 plus or minus 4 millimeters; and the highest single pulse energy is approximately 25 millijoules.

Three figures show the optical path of an experimental apparatus, an oscillograph of a mode-locked pulse train of a Nd:YAG laser, and pulse-duration curves by using the nonlinear secondary harmonic method.

The authors are grateful to Wu Zhaoqing [0702 0340 1987] and Zhao Shicheng [6392 0013 6134] of Shanghai Institute of Optics and Fine Mechanics for their assistance in experiments. The paper was received for publication on 9 October 1987.

An X-Ray Preionizator for Large-Volume and High-Pressure Excimer Lasers

40090056d Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 16 No 5, 20 May 89 pp 309-311

[Article by Ouyang Bin [2962 7122 2430] of Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences, and M. Steyer of Max-Planck-Institut fur Biophysikalische Chemie, Abteilung Laserphysik, West Germany]

[Abstract] The paper reports on an excimer preionization pulse X-ray source, adaptable to large volume, high gas-pressure short pulses, and stresses introducing the technique of obtaining a high-intensity fast rising X-ray source. In addition, the experimental results of other properties are given.

In order to build an excimer laser apparatus with short pulses and high output, indeed the main discharge circuit and discharge technique should be seriously studied; however, the preionization technique is also an important prerequisite. The article presents a technique for compressing X-ray pulses and the experimental results of obtaining a rising front fringe much shorter than 50 nanoseconds. Other properties are given in the final part of the article.

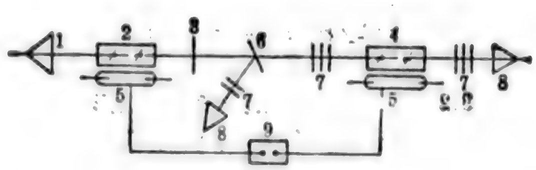
One table lists X-ray dosages varying with voltage and interelectrode spacing. Four figures show a cold cathode pulse X-ray source, X-ray and current waveforms of the same excitation voltage and different electrode spacing, and those of the same electrode spacing and different voltage excitation, as well as X-ray waveforms of capacitors with and without acceleration. This research was done at Max-Planck-Institut fur Biophysikalische Chemie, Abteilung Laserphysik, West Germany, under the supervision of Professor F. P. Schafer and with participation of K. Stankov. The authors are grateful to both individuals. The paper was received for publication on 22 November 1987.

Efficient Nd-Doped Phosphate Glass Laser

40090056e Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 16 No 5, 20 May 89 pp 311-313

[Article by Li Zhongya [2621 0112 0086/3660], Chen Zexing [7115 3419 5281] and Zhang Junchang [1728 6511 2490] of Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences]

[Abstract] The paper reports on a highly efficient phosphate glass laser, which was improved by the authors: they lowered the laser threshold value, and raised the laser efficiency. A laser efficiency of 2.6 percent was obtained by using a phosphate glass rod of ϕ 6 x 100 mm; the laser threshold value is 3.2 joules. An experimental set-up for gain measurement is shown in the following diagram:



Key:

1. Rotating lens
2. Oscillator laser rod
3. Output cavity sheet
4. Amplifier rod
5. Xenon light
6. Beam splitter lens
7. Filter plate
8. Energy meter
9. Time delay trigger

Four other figures show a comparison of pumping efficiencies of different lamps, the effect on laser output energy caused by light pumping time, correlation between laser output energy and light pumping energy, and a gain curve of an N_{2135} phosphate glass rod.

The paper was received for publication on 13 November 1987.

Crystal Structures and Superconductivity of a New Series of Superconducting Phases

81110727 Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 38 No 2, Feb 89 pp 264-272

[Article by Liang Jingkui [2733 2417 7608], Zhang Yuling [1728 3768 5376], Huang Jiuqi [7806 0036 7871], Xie Sishen [6043 1835 3819], Che Guanchan [6508 1639 3503], Cheng Xingrong [2052 0686 2837], Ni Yongming [0242 3057 2494], Zheng Dongning [6774 2639 1337], and Jia Shunlian [6328 7311 5571] of the Institute of Physics of the Chinese Academy of Sciences, manuscript received 17 Jun 88: "Crystal Structure and Superconductivity of a New Series of Superconducting Phases of $TlBaCa_{n-1}Cu_nO_{2n+2.5}$ (n=2,3)"]

[Text] Abstract

A new series of superconducting phases $TlBaCa_{n-1}Cu_nO_{2n+2.5}$ of the Tl-Ba-Ca-Cu-O system was synthesized by powder agglomeration. The crystal structures for n=2 and 3 were determined by powder X-ray diffraction to belong to the simple tetrahedral lattice category. The space group is D^1_{4k}-P4/mmm. They have the same lattice constant a, but different values of c; the latter increases with n. a = 3.847 Å and the values of c are 12.73 Å and 15.89 Å, respectively. Each cell contains a compound unit. The cations are distributed alternately along (0,0,z) and (1/2,1/2,z) in the same sequence of the tetrahedral system. More Ca and Cu and the corresponding oxygen ions are added when n=3 as compared to the case n=2.

For $TlBa_2Ca_{n-1}Cu_nO_{2n+2.5}$, when n=3, the zero resistance transition temperature $T_c(0)$=112 K. When n=2, $T_c(0)$=101 K. Different from the superconducting phase of the tetrahedral $Tl_2Ba_2Ca_{n-1}Cu_nO_{2n+4}$, the oxygen deficient pseudo-perovskite unit $[Ba_2Ca_{n-1}Cu_nO_{2n+1}]$ is only separated by a monolayer of Tl-O in the $TlBa_2Ca_{n-1}Cu_nO_{2n+2.5}$ structure. When n is the same, the superconducting transition temperature T_c of the body-centered tetrahedral lattice separated by two layers of Tl-O is approximately 10 K higher than that separated by a single layer of Tl-O. This demonstrates that T_c of the Tl-Ba-Ca-Cu-O system is not only dependent upon the number of $[CuO_4]$ and $[CuO_5]$ in the pseudo-perovskite unit, but also upon the number of Tl-O separation layers.

Since it was discovered that the initial superconducting transition temperature exceeds 100 K in the Bi-Sr-Ca-Cu-O system and the crystal structures were determined[1-7], superconductors in the Tl-Ba-Ca-Cu-O system were found to have a zero-resistance transition temperature at 120 K in early 1988[8-10]. Since then we determined the crystal structures of $Tl_2Ba_2Ca_1Cu_2O_8$[11] and $Tl_2Ba_2Ca_2Cu_3O_{10}$[12] and pointed out in reference [13] that a series of superconducting phases exists in the Tl-Ba-Ca-Cu-O system. The crystal structures are very similar. The cations are distributed alternately along (0,0,z) and (1/2,1/2,z). Because the stacking layers along the z-axis are different, there are different superconducting phases. This paper discusses the crystal structures and superconductivity of $TlBa_2Ca_{n-1}Cu_nO_{2n+2.5}$ (n=2 and 3).

I. Sample Preparation

The raw materials used for sample preparation included analytically pure Tl_2O_3, BaO, CaO and CuO powder. They were weighed out in different stoichiometric ratios, ground, mixed and cold pressed into pellets and sintered in air or oxygen at 790-800°C for 8 hours and cooled down to room temperature. Powder X-ray diffraction analysis of the samples showed that they contained multiple phases, including superconducting phases of different stacking layers, $BaCuO_2$ and CuO. Some specimens also contained CaO, Tl_2O_3 and copper calcium oxides. The sample used for the structural analysis of $TlBa_2CaCu_2O_{6.5}$ was prepared by sintering $TlBaCaCuO_{4.5}$ at 790°C. The sample used for the structural analysis of $TlBa_2Ca_2Cu_3O_{8.5}$ was prepared by sintering $Tl_2BaCaCu_2O_7$ at 790°C. It also contained a small amount of the $Tl_2Ba_2Ca_2Cu_3O_{10}$ phase.

II. Crystal Structure Analysis

The X-ray powder diffraction data used for structural analysis of $TlBa_2CaCu_2O_{6.5}$ and $TlBaCa_2Cu_3O_{8.5}$ was collected by a Philips APD-10 automatic powder diffractometer, and CuK_α radiation and CoK_α radiation were measured with a Guinier-de Wolff monochromatic focusing transmission camera. The diffraction lines from other impurity phases were removed. Pure Si was used for internal calibration of the diffraction angle. The results are shown in Tables 1 and 2.

All the diffraction lines of the two superconducting phases can be indexed by Werner's TREOR program[14]. They are simple tetrahedral lattices and there is no extinction. The lattice constants of $TlBa_2CaCu_3O_{6.5}$ are a = 3.847 Å and c = 12.73 Å. The lattice constants of $TlBa_2Ca_2Cu_3O_{8.5}$ are a = 3.847 Å and c = 15.89 Å. Due to the similarity of the crystal structure of the superconducting phases, the most probable space group is D^1_{4h}-P4/mmm.

Because a is very small for this tetrahedral lattice, cations can only be distributed alternately along (0,0,z) and (1/2,1/2,z). Based on the crystal structure already determined for the Tl-Ba-Ca-Cu-O system, the cation layer distance perpendicular to the z-axis is very close. In the crystal structures of $Tl_2Ba_2CaCu_2O_8$[11] and $Tl_2Ba_2Ca_2Cu_3O_{10}$[12], Ca is next to a Cu-O layer.

Table 1. Comparison of Calculated and Observed Values of Diffraction Intensity I and Crystal Surface Distance d for $TlBa_2CaCu_2O_{6.5}$

h	k	l	d_{calc}	d_{obs}	I_{calc}	I_{obs}
0	0	1	12.73	12.71	20.6	w-m
0	0	2	6.365	—	0.8	–
0	0	3	4.243	4.230	9.0	6
1	0	0	3.847	3.846	1.0	vw
1	0	1	3.682	3.678	6.7	7
1	0	2	3.292	3.290	84.6	70
0	0	4	3.182	3.175	11.6	13
1	0	3	2.850	2.848	100.0	100
1	1	0	2.720	2.720	84.5	88
1	1	1	2.660	2.656	14.1	10
0	0	5	2.546	2.542	27.7	59
1	1	2	2.501	—	0.0	–
1	0	4	2.452	2.450	7.7	21
1	1	3	2.290	2.286	1.2	vw
1	0	5	2.123	2.119	3.4	9
0	0	6	2.122		1.3	
1	1	4	2.068	2.068	29.5	30
2	0	0	1.923	1.924	41.9	49
2	0	1	1.902	—	1.4	–
1	1	5	1.859	1.857	29.9	32
1	0	6	1.858		8.5	
2	0	2	1.841	—	0.0	–
0	0	7	1.819	1.813	1.9	vw
2	0	3	1.752	1.747	2.8	vw
2	1	0	1.720	—	0.3	–
2	1	1	1.7049	1.7015	1.7	9
1	1	6	1.6730	1.6710	2.2	vw
2	1	2	1.6608	1.6614	24.9	21
2	0	4	1.6462	1.6421	6.8	24
1	0	7	1.6441		11.5	
2	1	3	1.5944	1.5950	33.9	37
0	0	8	1.5912		3.9	
2	0	5	1.5347	1.5344	20.1	18

[Continued on following page]

h	k	l	d_{calc}	d_{obs}	I_{calc}	I_{obs}
2	1	4	1.5134	1.5141	2.7	11
1	1	7	1.5118		1.7	
1	0	8	1.4704	1.4675	4.8	5
2	1	5	1.4255	—	1.6	—
2	0	6	1.4250	—	1.3	—
0	0	9	1.4144	—	1.6	—
1	1	8	1.3735	1.3770	5.5	5
2	2	0	1.3601	1.3607	11.6	12
2	2	1	1.3524	—	0.5	—
2	1	6	1.3363	1.3340	5.8	5
2	2	2	1.3301	—	0.0	—
1	0	9	1.3276	1.3246	0.2	vw
2	0	7	1.3215		2.1	
2	2	3	1.2952	—	0.8	—
3	0	0	1.2823	—	0.0	—
3	0	1	1.2759	1.2750	0.3	vw
0	0	10	1.2730		1.0	
3	0	2	1.2571	1.2518	4.9	12
1	1	9	1.2549		5.6	
2	2	4	1.2507	1.2498	2.7	15
2	1	7	1.2498		9.3	
3	0	3	1.2275	1.2270	6.7	13
2	0	8	1.2261		5.7	
3	1	0	1.2165	1.2170	11.9	14
3	1	1	1.2110		1.9	
1	0	10	1.2086	—	0.1	—
2	2	5	1.1997	1.1970	8.1	10

Table 2. Comparison of Calculated and Observed Values of Diffraction Intensity I and Crystal Surface Distance d for $TlBa_2CaCu_3O_{8.5}$

h	k	l	d_{calc}	d_{obs}	I_{calc}	I_{obs}
0	0	1	15.89	16.07	52	m
0	0	4	3.973	3.981	18	w
1	0	0	3.847	——	2	—
1	0	1	3.739	——	2	—
0	0	5	3.178	——	8	—
1	0	3	3.113	3.115	99	s
1	0	4	3.764	2.763	68	m
1	1	0	2.720	2.718	100	s
1	1	1	2.681	2.680	20	w
0	0	6	2.648	2.649	32	w—m
1	0	5	2.450	2.488	26	m
0	0	7	2.270	——	5	—
1	1	4	2.245	——	6	—
1	0	6	2.181	——	6	—
1	1	5	2.065	2.064	36	m
1	0	7	1.955	——	8	—
2	0	0	1.924	1.920	64	s
2	0	1	1.910	——	2	—
1	1	6	1.898	1.894	35	m
0	0	9	1.766	1.766	1	w
1	0	8	1.765		16	
1	1	7	1.743	1.745	9	vw
2	0	4	1.731	——	8	—
2	1	2	1.682	1.682	18	w
2	0	5	1.646	——	7	—
2	1	3	1.636	1.637	43	m
1	0	9	1.605	1.608	11	w
0	0	10	1.589	1.596	11	vw
2	1	4	1.579	1.581	34	m
2	0	6	1.556	1.560	32	m
2	1	5	1.513	1.517	15	w
1	1	9	1.481	——	1	—
1	0	10	1.469	1.473	5	w
2	0	7	1.468		8	
0	0	11	1.445	——	2	—
2	1	6	1.443	——	4	—
1	1	10	1.372	1.372	22	m
2	1	7	1.371		10	
2	2	0	1.360	1.364	31	m
2	2	1	1.355	——	2	—
0	0	12	1.324	——	2	—

The distances are 1.47 Å and 1.61 Å, respectively. In addition to being next to a layer of Cu-O, Ca is next to a layer of Ba-O. The distances are 1.91 Å and 1.97 Å, respectively. Besides a layer of Cu-O, Ba-O is also next to a layer of Tl-O. The distances are 2.86 Å and 2.79 Å, respectively. In addition to being next to a layer of Ba-O, Tl-O is also next to another layer of Tl-O. The distances are 2.06 Å and 1.93 Å, respectively. Due to similarity of the superconducting phase of the Tl-Ba-Ca-Cu-O system, it is not difficult to predict that the ideal chemical formula for a crystal with c = 12.73 Å is $TlBa_2CaCu_2O_{6.5}$. The cations are distributed alternately along the z-axis in the sequence of Tl-Ba-Cu-Ca-Cu-Ba-Tl. When c = 15.89 Å, the ideal compound formula is $TlBa_2Ca_2Cu_3O_{8.5}$. The sequence of cation distribution along the z-axis is Tl-Ba-Cu-Ca-Cu-Ca-Cu-Ba-Tl.

Based on the fact that cation positions are roughly fixed, the distribution of oxygen ions can be determined based on the shape of the superconducting polygon, the distance between ions and the Pauling valence balance rule. The structural analysis program LAZY was used to continuously adjust atomic parameters and repeatedly perform computation. Tables 3 and 4 show some atomic parameters for $TlBa_2CaCu_2O_{6.5}$ and $TlBa_2Ca_2Cu_3O_{8.5}$ which are in good agreement with experimental results.

Table 3. Atomic Parameters of the Crystal Structure of $TlBa_2CaCu_2O_{6.5}$

Ion	Equivalent lattice	x	y	z	Occupancy rate	Total number of ions
Ca	1(*a*)	0	0	0	1	1
Ba	2(*g*)	0	0	0.281	1	2
Tl	1(*d*)	1/2	1/2	0.5	1	1
Cu	2(*h*)	1/2	1/2	0.127	1	2
O(1)	4(*i*)	0	1/2	0.127	0.929	3.716
O(2)	2(*h*)	1/2	1/2	0.281	0.929	1.858
O(3)	1(*b*)	0	0	0.5	0.929	0.929

Table 4. Atomic Parameters of the Crystal Structure of $TlBa_2Ca_2Cu_3O_{8.5}$

Ion	Equivalent lattice	x	y	z	Occupancy rate	Total number of ions
Ca	2(*g*)	0	0	0.100	1	2
Ba	2(*g*)	0	0	0.320	1	2
Tl	1(*d*)	1/2	1/2	0.5	1	1
Cu(1)	1(*c*)	1/2	1/2	0	1	1
Cu(2)	2(*h*)	1/2	1/2	0.200	1	2
O(1)	4(*i*)	0	1/2	0.200	0.945	3.780
O(2)	2(*f*)	0	1/2	0	0.945	1.890
O(3)	2(*h*)	1/2	1/2	0.325	0.945	1.890
O(4)	1(*b*)	0	0	0.5	0.945	0.945

In Table 1, either the diffraction intensity is low or diffraction angle is small; no diffraction line was observed on the APD-10 diffractometer for $TlBa_2CaCu_2O_{6.5}$ (only collecting 2θ = 16-80°). We used the result obtained from the Guinier-de Wolff monochromatic focusing camera. The diffraction lines were visually measured. If we do not include the diffraction lines not measured by the APD-10 diffractometer but observed on the Guinier-de Wolff picture on the R factor ($R = \Sigma|I_{calc}-I_{obs}|/\Sigma I_{obs}$), then R = 0.18. Hence, it is believed that the results are reliable. The primary cause for any deviation is d = 2.542 Å and 2.450 Å and the high intensity of the (hk0) diffraction line. This may be due to an overlap with other diffraction lines of other phases. In Table 2, the calculated diffraction intensity of $TlBa_2Ca_2Cu_3O_{8.5}$ is essentially consistent with the visual observation made with a Guinier-de Wolff camera. We did not see any inconsistency. Further refinement of the atomic parameters requires the preparation of pure single-phase specimen or single crystal.

Figure 1 shows the crystal structures of $TlBa_2CaCu_2O_{6.5}$ and $TlBa_2Ca_2Cu_3O_{8.5}$. The general expression is $TlBa_2Ca_{n-1}Cu_nO_{2n+2.5}$. From Figure 1 we can see that two superconducting phases are very similar. The structure of $TlBa_2Ca_2Cu_3O_{8.5}$ is based on the structure of $TlBa_2CaCu_2O_{6.5}$ with an additional layer of Ca and Cu and their associated oxygen ions. In $TlBa_2CaCu_2O_{6.5}$ and $TlBa_2Ca_2Cu_3O_{8.5}$, the cation distribution sequence is identical. The layer distance perpendicular to the z-axis is also similar. The distances between the Ca layer and Cu-O layer are 1.62 Å and 1.59 Å, respectively. The distances between the Cu-O layer and Ba-O layer are 1.96 Å and 1.91 Å, respectively. The distances between the Ba-O layer and Tl-O layer are 2.79 Å and 2.86 Å, respectively. In $Tl_2Ba_2CaCu_2O_8$ and $Tl_2Ba_2CaCu_3O_{10}$ the cation layer distances are also very close to these numbers. Since all superconducting phases in the Tl-Ba-Ca-Cu-O system have similar structures, it is possible to derive the ideal chemical formula and approximate atomic positions based on d_1 of the first diffraction line (001).

In a simple tetrahedral cell such as the superconducting phase $TlBa_2Ca_{n-1}Cu_nO_{2n+2.5}$, the empirical relation between d_1 and n is:

$$d_1 \simeq 2[1.57(n-1) + 1.94 + 1.82] \text{ Å}.$$

In a body-centered tetrahedral cell such as the superconducting phase $Tl_2Ba_2Ca_{n-1}Cu_nO_{2n+4}$, the empirical relation between d_1 and n is:

$$d_1 \simeq 2[1.57(n-1) + 1.94 + 1.82] + 2.0 \text{ Å}.$$

The two structures have the same polygon for the distribution of cations (Cu, Ca, Ba, Tl) and oxygen ions. As shown in Figure 2, Cu is a cone with a coordination number of five (when $n \geq 3$, a tetragon with a coordination number of four). Ca is a cube with a coordination number of eight. Tl is a distorted octahedron with a coordination number of six. Ba is a tridecahedron with a coordination number of nine. The distances between the cations and oxygen ions are shown in Tables 5 and 6.

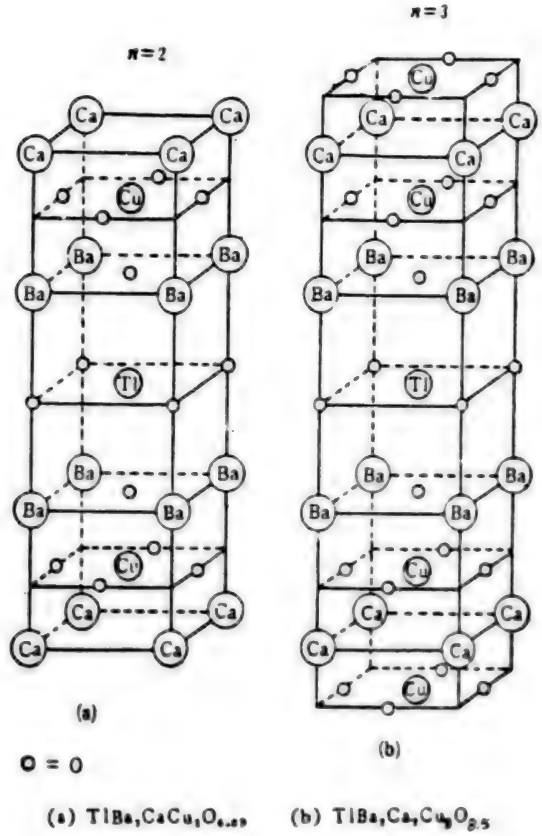


Figure 1. Crystal Structure of $TlBa_2Ca_{n-1}Cu_nO_{2n+2.5}$

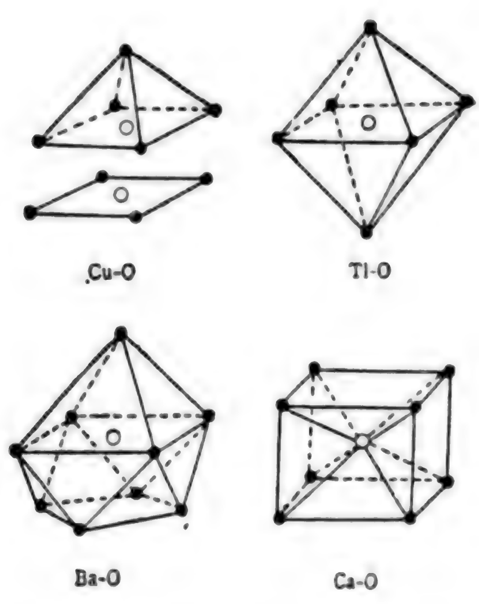


Figure 2. The Polyhedrons for Cations (Cu, Ca, Tl, Ba)-Oxygen Ions

Table 5. Distance Between Cation and Oxygen Ion in $TlBa_2CaCu_2O_{6.5}$

Cu-4O(1) 1.92Å Cu-1O(2) 1.96Å	Tl-4O(3) 2.72Å Tl-2O(2) 2.79Å
Ca-8O(1) 2.51Å	Ba-4O(2) 2.72Å Ba-4O(1) 2.75Å Ba-1O(3) 2.79Å

Table 6. Distance Between Cation and Oxygen Ion for $TlBa_2Ca_2Cu_3O_{8.5}$

Cu(1)-4O(2) 1.92Å Cu(2)-4O(1) 1.92Å Cu(2)-1O(3) 1.99Å	Ba-4O(3) 2.72Å Ba-4O(1) 2.71Å Ba-1O(4) 2.86Å
Ca—4O(1) 2.49Å Ca—4O(2) 2.49Å	Tl-4O(4) 2.72Å Tl-2O(3) 2.78Å

The crystal structures of the superconducting phases in the Tl-Ba-Ca-Cu-O system are staked up by two basic elements along the z-axis, i.e., the oxygen-deficient perovskite $Ba_2Ca_{n-1}Cu_nO_{2n+1}$ of various n values and different layers of Tl-O. When the separation layer is a single layer of Tl-O, $Ba_2Ca_{n-1}Cu_nO_{2n+1}$ of various n values are distributed symmetrically on both sides of the Tl-O layer to form a simple cubic lattice. When the separation layer is a double layer of Tl-O, in order to maintain dense stacking of ions, the two layers of Tl-O are (1/2,1/2) offset on the x-y plane. Consequently, $Ba_2Ca_{n-1}Cu_nO_{2n+1}$ are also offset accordingly to form a body-centered cubic lattice. The lattice parameter c is doubled.

In the Tl-Ba-Ca-Cu-O system, the structures of different superconducting phases are very similar and closely related. Therefore, the difference in their free energy of formation is very small. Under slightly different sintering conditions, it is easy to form mixed phases. The samples we obtained usually contained two or three superconducting phases. It is difficult to obtain a pure superconducting phase, especially when n is large. It is also possible to have oxygen-deficient perovskites of different n values on both sides of the Tl-O layer. For example, under a high-resolution electron microscope, two types of $Ba_2Ca_{n-1}Cu_nO_{2n+1}$ of different n values were found to grow alternately[15].

III. Superconductivity

Resistance was measured by the standard quadruple method and magnetic susceptibility was measured by a mutual inductance bridge. Figures 3 and 4 show the superconductivity of $TlBa_2CaCu_2O_{6.5}$ and $TlBa_2Ca_2Cu_3O_{8.5}$. In the

sample with $TlBa_2CaCu_2O_{6.5}$ as its primary phase, $T_c(0) = 101.4$ K and diamagnetism took place at 89.4 K (see Figure 3). In the sample with $TlBa_2Ca_2Cu_3O_{8.5}$ as its primary phase, $T_c(0) = 112$ K and diamagnetism occurred at 111 K (see Figure 4).

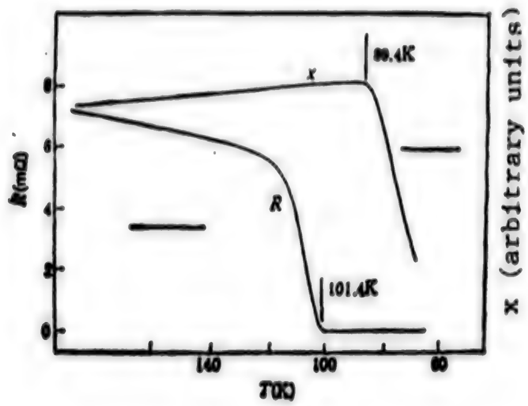


Figure 3. Dependence of Resistance and Magnetic Permeability Upon Temperature in a Sample With $TlBa_2CaCu_2O_{6.5}$ as Its Primary Phase

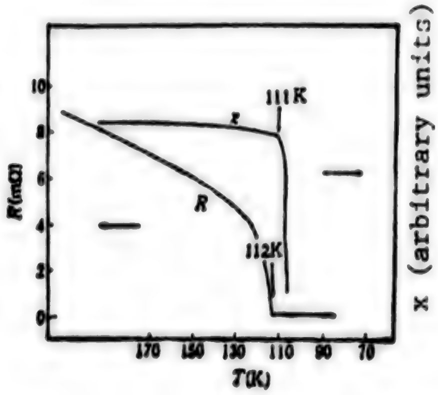


Figure 4. Dependence of Resistance and Magnetic Permeability Upon Temperature in a Sample With $TlBa_2Ca_2Cu_3O_{8.5}$ as Its Primary Phase

In the Tl-Ba-Ca-Cu-O system the superconducting transition temperature depends on the way the superconducting phase is stacked. The larger n becomes, i.e., the larger the number of Cu-O tetrahedrons with coordination number of four and cones with coordination number of five is, and the more Tl-O separation layers there are, the higher the superconducting transition temperature is. For a body-centered lattice with a double Tl-O separation layer such as $Tl_2Ba_2Ca_{n-1}Cu_nO_{2n+4}$, $T_c(0) = 100$ K[11] when n = 2, and $T_c(0) = 120$ K[12] when n = 3. Because the sample contained other superconducting phases, the measurement of superconducting transition temperature might be affected. Nevertheless, the overall trend is that, with the same Tl-O layer, the superconducting transition temperature can be raised by approximately 20 K when n is increased by 1. When n remains the same, the transition from a

simple cubic single Tl-O layer to a body-centered cubic lattice with two layers of Tl-O can raise T_c by approximately 10 K. It is estimated that when n = 10 the d value of the first diffraction line is near 40 Å. Thus, room-temperature superconductors might be possible. Of course, this kind of stacking might be very unstable and will be difficult to make. However, if a stable superconductor with a high number of stacking layers can be attained, the superconducting transition temperature will rise accordingly.

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China's Synchronous Accelerator Becomes Operational

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[Article by Xuan Fenghua [1357 1144 5478] and Tian Wenshan [3944 2429 0810]: "China's Synchronous Radiation Accelerator Is Completed, Becomes Operational"]

[Text] Good news was announced in the early morning of 0108 hours on 26 April 1989 at the new campus of China University of Science and Technology in the southern suburbs of Hefei City, Anhui Province: China's first special purpose synchronous radiation light source was completed and generated light. It took just 23 hours from the first injection of the electron beam into the storage ring to obtain a stored beam and generate light blue synchronous radiation light, the world's fastest debugged light output in a similar device to date.

This major achievement follows China's successful detonation of the atomic and hydrogen bombs, launching and recovery of an artificial satellite, completion of the Beijing Electron-Positron Collider, and other things, and it indicates that Chinese technologies for building synchronous radiation accelerators have entered the advanced ranks of the world.

This project was included in state science and technology development plans in 1977 and became a key state construction project in 1983 after receiving State Planning Commission approval and being named the "National Synchronous Radiation Laboratory Project." Formal laying of the foundation for construction was done on 20 November 1984. Completion of the National Synchronous Radiation Accelerator also indicates the birth of China's first national level public laboratory.

The National Synchronous Radiation Laboratory is a burgeoning development internationally in research on synchronous radiation and there are many disciplines, particularly applied fields and developing fields, which urgently need to start design and research with the synchronous radiation light source. Its completion provides many fields in China with a powerful research tool which will promote rapid development of China's national economy, advanced science and technology, and national defense construction, and even serve the four modernizations drive.

The National Synchronous Radiation Laboratory, located at the China University of Science and Technology in the southern suburbs of Hefei City, occupies about 150 mu of land and has structures covering 12,900 m^2. The main parts are the

injector, storage ring, and synchronous radiation laboratory. The injector is a 35 meter-long linear electron accelerator with an energy level of 200 MeV. The storage ring is a circular accelerator 66 meters in circumference with an energy level of 800 MeV. Twenty-seven light beam lines can be drawn from the storage ring, enabling simultaneous experimental research by hundreds of S&T personnel in many disciplines. Five ports are now open and there are five light beam lines and five experiment stations. Additional light beam lines and experiment stations will be built in the near future for continued expansion of the scope of applications.

The waveband of the Hefei electron synchronous radiation light source is approximately the same as the light source at the Beijing Electron-Positron Collider, and they are mutually complementary and supplementary in the areas of energy ranges and applications.

This special purpose synchronous radiation light source was independently designed and developed by many Chinese middle aged and young S&T personnel who absorbed the good points of many similar devices internationally on the basis of prefabrication studies and began with real conditions and needs in China. It is in the advanced ranks of similar devices internationally in terms of performance.

According to the relevant experts, it was not until the late 1970's that world research on synchronous radiation began to grow rapidly into a completely new field of accelerator applications. Synchronous radiation applications are just unfolding. Many developed nations have formulated national plans for utilizing synchronous radiation light sources. The United States, Federal Republic of Germany, France, England, Japan, Soviet Union, Italy, and other nations altogether have more than 30 special-purpose and multi-purpose synchronous radiation facilities in operation and more than ten additional special purpose facilities are now being designed or built. China's Taiwan Province also is building a special purpose synchronous radiation light source.

The newly-completed Hefei Synchronous Radiation Light Source is a large multi-purpose new light source. It can provide high intensity, highly stable radiation light in the infrared, visible light, vacuum ultraviolet, and even short X-ray spectral ranges. Its performance is superior in areas like strong intensity, high luminosity, continuous spectrum, good directionality, good polarization, cleanliness, ability to accurately calculate wave spectra, superior time structure, short pulse time, and so on, so it can be used in physics, chemistry, biology, and other basic disciplines as well as in a wide range of applications like design, astronomy, medicine, materials science, surface sciences, micro technologies, ultramicro fine processing, ultra-large scale integrated circuit photoetching, and other S&T realms.

The National Synchronous Radiation Laboratory project received considerable attention from CPC and state leaders. Comrade Deng Xiaoping has consistently been concerned with this project and given it a great deal of support. CPC General Secretary Zhao Ziyang personally visited the site. Hu Qili [5170 0796 4539] and Yan Jici [0917 3444 1964] participated in the groundbreaking ceremonies. Yao Yilin [1202 0181 2651], Fang Yi [2455 3015], Song Jian [1345 0256], and others also wrote instructions, made inspections, and aided in solving concrete difficulties in construction.

Many renowned foreign scientists like Yang Zhenning [2799 2182 1337], Li Zhengdao [2621 2398 6670], Wu Jianxiong [0702 0256 7160], Yuan Jialiu [5913 1367 7511], Ding Zhao [0002 5128], and others, and an older generation of Chinese scientists like Wang Ganchang [3769 3227 2490], Zhang Wenyu [1728 2429 5940], and others supported and assisted this project and they have evaluated it highly.

Chinese S&T personnel independently designed and independently manufactured, installed, and debugged this synchronous radiation light source in its entirety. It embodies the strength and unified cooperation of China's S&T circles. Because the components were basically produced within China, the state saved a great deal of foreign exchange. The project was completed more than 1 year ahead of the time set for completion by the state and compares favorably with the world's most advanced similar facilities in speed of construction, engineering quality, project cost, and other areas.

The key force in building this enormous and incisive scientific research project was the many middle aged and young S&T personnel from China University of Science and Technology. Their average age is just 38 years. They worked on this project despite very difficult conditions including moving the school, a shaky environment, insufficient staffing, a lack of experience, finances, and material strengths, and other things. However, they contributed to the cause of advanced S&T in China and their strong sense of responsibility and sense of mission for achievement made them unyielding, fear no difficulties, and rely on their own efforts and tenacity to spend 10 years of painstaking labor from prefabrication to completion. They had no special material rewards and automatically gave up many winter vacations and vacation days, ignored sickness in their families, had no time to assist sons and daughters taking college entrance examinations, turned down opportunities for jobs in foreign countries or going abroad to study, and worked many sleepless nights. Many saw their hair turn grey prematurely. Many workers in plants responsible for processing these components were deeply moved by their selfless spirit of devotion and decided to fight together with them shoulder to shoulder in completing their tasks with a high degree of quality.

When construction of the synchronous radiation light source began, China University of Science and Technology was already making plans for its use. They held the first synchronous radiation applications study and discussion class in April 1983 in Hefei, translated many foreign works on synchronous radiation applications, invited several famous experts from China and foreign countries to come to make scholarly reports, and sent personnel to foreign countries for research and examination in synchronous radiation applications. After September 1984, they invited the relevant research institutes and plants to come on two occasions for special research to establish a photoetching laboratory line and do research on photoetching.

China now has over 90 units which want to come to the National Synchronous Radiation Laboratory to do experimental research and four users' conferences have been held. On 9 May 1989, the International Synchronous Radiation Applications Conference will open in Hefei and will be attended by nearly 40 experts from over ten countries including the United States, England, France, Federal Republic of Germany, Japan, Italy, Soviet Union, developing nations like India, Brazil, South Korea, and others, and by about 50 Chinese experts.

Bao Zhongmou [0545 1813 6180], vice president of China University of Science and Technology and manger of the National Synchronous Radiation Laboratory project told reporters that "as a public national level laboratory, the Hefei Synchronous Radiation Facility is open to all units and the entire world. We welcome scientific research organs in all nations, all institutions of higher education, and all plants and enterprises to link up with and closely cooperate with us broadly in a joint effort to open up the magnificent prospects for synchronous radiation applications in China, and we welcome the relevant units in foreign countries, especially in the developing nations of the Third World, to come and use this new light source."

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